

111775

ENVIRONMENTAL PROTECTION AGENCY
ALTERNATIVE REMEDIAL CONTRACTING STRATEGY (ARCS)

REGION III

CONTRACT #68-W8-0092

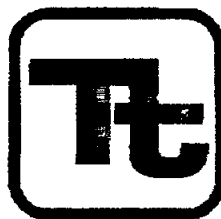
WORK ASSIGNMENT #92-12-3L54

REMEDIAL INVESTIGATION REPORT

JUNE 24, 1991

HAVERTOWN PCP SITE
HAVERTOWN, PENNSYLVANIA

TETRA TECH, INC.



TCN 4212

AR300785

ENVIRONMENTAL PROTECTION AGENCY
ALTERNATIVE REMEDIAL CONTRACTING STRATEGY (ARCS)

REGION III

CONTRACT #68-W8-0092

WORK ASSIGNMENT #92-12-3L54

REMEDIAL INVESTIGATION REPORT

APRIL 22, 1991

HAVERTOWN PCP SITE
HAVERTOWN, PENNSYLVANIA

CARL K. HSU, PH.D., P.E.
PROGRAM DIRECTOR
TETRA TECH, INC.

AR300786

TABLE OF CONTENTS

	<u>PAGE</u>
1. INTRODUCTION	1-1
1.1 PURPOSE OF REPORT	1-1
1.2 SITE BACKGROUND	1-2
2. PHYSICAL CHARACTERISTICS OF STUDY AREA	2-1
2.1 DEMOGRAPHY	2-1
2.2 METEOROLOGY	2-1
2.3 GEOLOGY	2-2
2.4 HYDROGEOLOGY	2-2
2.5 PUBLIC WATER SUPPLY	2-5
2.6 SURFACE FEATURES	2-5
2.7 SURFACE HYDROLOGY	2-5
2.8 SOILS	2-7
2.9 ECOLOGY	2-7
3. STUDY AREA FIELD INVESTIGATION	3-1
3.1 GROUND-WATER INVESTIGATION	3-1
3.2 INVESTIGATION OF NAYLORS RUN AND COBBS CREEK	3-7
3.3 STORM SEWER INVESTIGATION	3-10
3.4 ECOLOGICAL INVESTIGATION	3-14
4. RESULTS OF INVESTIGATION	4-1
4.1 DATA USE	4-1
4.2 HYDROGEOLOGICAL INVESTIGATION	4-3
4.3 INVESTIGATION OF NAYLORS RUN AND COBBS CREEK	4-15
4.4 STORM SEWER INVESTIGATION	4-24
4.5 ECOLOGICAL INVESTIGATION	4-27
5. CONTAMINANT FATE AND TRANSPORT	5-1
5.1 POTENTIAL ROUTES OF MIGRATION	5-1
5.2 CONTAMINANT PERSISTENCE	5-4
5.3 CONTAMINANT MIGRATION	5-6
6. BASELINE RISK ASSESSMENT	6-1
6.1 HUMAN HEALTH EVALUATION	
(INCLUDED UNDER SEPARATE COVER)	
6.2 ECOLOGICAL EVALUATION	
(INCLUDED UNDER SEPARATE COVER)	

AR300787

TABLE OF CONTENTS
(Continued)

	<u>PAGE</u>
7. SUMMARY AND CONCLUSIONS	7-1
7.1 SUMMARY	7-1
7.1.1 NATURE AND EXTENT OF CONTAMINATION	7-1
7.1.2 FATE AND TRANSPORT	7-4
7.1.3 RISK ASSESSMETN	7-7
7.2 CONCLUSIONS	7-9
7.2.1 DATA LIMITATIONS AND RECOMMENDATIONS FOR ADDITIONAL WORK	7-9
7.2.2 RECOMMENDED REMEDIAL ACTION OBJECTIVES	7-10
8. REFERENCES	8-1

AR300788

TABLE OF CONTENTS
(continued)

LIST OF FIGURES		PAGE
FIGURE 1-1	GENERAL LOCATION MAP	1-3
FIGURE 1-2	SITE MAP	1-4
FIGURE 2-1	GENERAL GEOLOGIC MAP	2-3
FIGURE 2-2	GEOLOGICAL CROSS SECTION	2-4
FIGURE 2-3	MAP OF PUBLIC WATER SUPPLY SOURCES	2-6
FIGURE 2-4	SOIL MAP	2-8
FIGURE 3-1	WELL LOCATION MAP	3-2
FIGURE 3-2	SURFACE WATER & SEDIMENT SAMPLING LOCATIONS	3-9
FIGURE 3-3	STORM SEWER SAMPLING LOCATIONS	3-12
FIGURE 3-4	STORM SEWER TV INSPECTION	3-13
FIGURE 4-1	WATER LEVEL CHANGE IN 6 SELECTED WELLS	4-7
FIGURE 4-2	TOTAL RAINFALL - PHILADELPHIA AIRPORT	4-8
FIGURE 4-3	WATER LEVEL DATA - SHALLOW HYDROLOGIC ZONE	4-42
FIGURE 4-4	WATER LEVEL DATA - DEEP HYDROLOGIC ZONE	4-43
FIGURE 4-5	VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND WATER - NOV 7-15, 1990	4-44
FIGURE 4-6	VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND WATER - 1988	4-45
FIGURE 4-7	SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND WATER - NOV 7-15, 1990	4-46
FIGURE 4-8	SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND WATER - 1988	4-47
FIGURE 4-9	DIOXIN DETECTED IN GROUND WATER - NOV 7-15, 1990	4-48
FIGURE 4-10	DIOXIN DETECTED IN GROUND WATER - 1988	4-49
FIGURE 4-11	VOLATILE ORGANIC COMPOUNDS DETECTED IN NAYLORS RUN AND STORM SEWER - SEPT, 1990	4-50
FIGURE 4-12	TOTAL VOLATILE ORGANIC COMPOUNDS DETECTED IN NAYLORS RUN - 1988	4-51
FIGURE 4-13	SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN NAYLORS RUN AND STORM SEWER - SEPT, 1990	4-52
FIGURE 4-14	SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN NAYLORS RUN AND COBBS CREEK - SEPT, 1990 & JAN 1991	4-53
FIGURE 4-15	SEMI-VOLATILE ORGANIC COMPOUNDS DETECTED IN NAYLORS RUN - 1988	4-54
FIGURE 4-16	DIOXIN DETECTED IN NAYLORS RUN AND STORM SEWER (TCDD TOX. EQUIV.) - SEPT, 1990	4-55
FIGURE 4-17	DIOXIN DETECTED IN NAYLORS RUN (TCDD TOX. EQUIV.) - 1988	4-56
FIGURE 5-1	VOLATILE AND SEMI-VOLATILE ORGANIC COMPOUNDS IN SOIL - NWP PROPERTY, 1988	5-2
FIGURE 5-2	GENERAL FATE AND TRANSPORT PROCESSES	5-7
FIGURE 5-3	TWO DIMENSIONAL HORIZONTAL FLOW WITH CONTINUOUS SOLUTE SOURCES ANALYTICAL SOLUTION SUMMARY	AR300788
FIGURE 5-4	RELATIONSHIP BETWEEN STREAM VELOCITY, PARTICLE SIZE, AND REGIMES OF EROSION, TRANSPORT, AND DEPOSITION	5-13

TABLE OF CONTENTS
(continued)

PAGE

LIST OF TABLES

TABLE 1-1	SITE CHRONOLOGY	1-6
TABLE 1-2	RESULTS OF BOREHOLE GEOPHYSICAL LOGGING, 1989	1-17
TABLE 3-1	SUMMARY OF MONITORING WELL CONSTRUCTION	3-4
TABLE 3-2	GROUND-WATER SAMPLING - ROUND 1 (8/90)	3-5
TABLE 3-3	GROUND-WATER SAMPLING - ROUND 2 (11/90)	3-6
TABLE 4-1	WATER LEVEL ELEVATIONS	4-4
TABLE 4-2	VERTICAL GRADIENTS AND DIRECTION OF FLOW	4-10
TABLE 4-3	SURFACE WATER AND SEDIMENT SAMPLING	4-16
TABLE 4-4	GRAIN SIZE DATA	4-18
TABLE 4-5	TOTAL ORGANIC CARBON IN SEDIMENT	4-23
TABLE 4-6	RESULTS OF TV INSPECTION OF STORM SEWER	4-25
TABLE 4-7	BENTHIC MACROINVERTEBRATE COLLECTION SUMMARY	4-28
TABLE 4-8	POTENTIAL RECEPTORS IN THE NAYLORS RUN STUDY AREA	4-29
TABLE 7-1	COMPARISON OF RESULTS - 1988 VS 1990-1991	7-5

APPENDICES:

APPENDIX A	ECOLOGICAL FIELD METHODOLOGIES
APPENDIX B	GROUND-WATER DATA
APPENDIX C	GRAIN SIZE DATA; SEDIMENTS FROM NAYLORS RUN AND COBBS CREEK
APPENDIX D	SURFACE WATER AND SEDIMENT DATA
APPENDIX E	STORM SEWER WATER AND SEDIMENT DATA
APPENDIX F	ECOLOGICAL DATA

AR300790

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

The United States Environmental Protection Agency (USEPA), Region III, using the Alternative Remedial Contracting Strategy (ARCS), authorized Tetra Tech, Inc. (Tetra Tech) to perform a Remedial Investigation/Feasibility Study (RI/FS) at the Havertown PCP (HAVERTOWN) site, Havertown, Pennsylvania. The RI/FS activities were performed under Work Assignment 92-12-3L54.0, dated December 5, 1989. All work for this RI was completed during the period January, 1990 to April, 1991. All RI/FS activities were based on regulations and procedures for implementing response actions set forth in the National Oil and Hazardous Substances Contingency Plan (NCP) as amended.

The two primary objectives of this Remedial Investigation as defined in the 1989 Record of Decision (ROD) for the HAVERTOWN site were to assess:

- the current magnitude and extent of ground surface water and sediment contamination at the site; and
- the potential health risk due to the public's exposure to ground water from the site and surface water and sediments from Naylor's Run.

A field effort was initiated to address the remedial objectives, and included: sampling of ground water from 28 monitoring wells; a video inspection of the storm sewers emptying into Naylor's Run; sampling of surface water and sediments from storm sewers emptying into Naylor's Run; sampling of surface water and sediments from Naylor's Run and Cobbs Creek; and an ecological assessment of portions of Naylor's Run and Cobbs Creek. Evaluation of contaminant transport pathways and potential risk to human health and the environment has been based collectively upon the data collected during this and previous field efforts.

This report summarizes the Remedial Investigation phase of RI/FS only. The Feasibility Study will be submitted under separate cover. The information contained within this report includes: background information on the site, AR300791

including a description of some of the previous investigations performed; a general description of the physical characteristics of the site; a description of the field activities performed; a summary of the data collected; an evaluation of the extent of contamination; a description of the pathways of migration for any contamination; an evaluation of the risk to human health and the environment posed by any contamination; and recommendations of alternatives for the remediation of the site.

The Remedial Investigation was performed in accordance with project plans (i.e., Work Plan, Field Sampling Plan, Quality Assurance Project Plan, and Health and Safety Plan) submitted to the USEPA by Tetra Tech for the HAVERTOWN PCP site.

1.2 SITE BACKGROUND

The HAVERTOWN site has an extensive regulatory history, which has been presented in detail in the Remedial Investigation Report completed in 1988 by R. E. Wright Associates, Inc., (REWAI). Much of the background information presented here has been excerpted or summarized from that document.

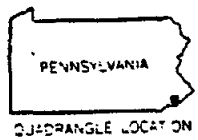
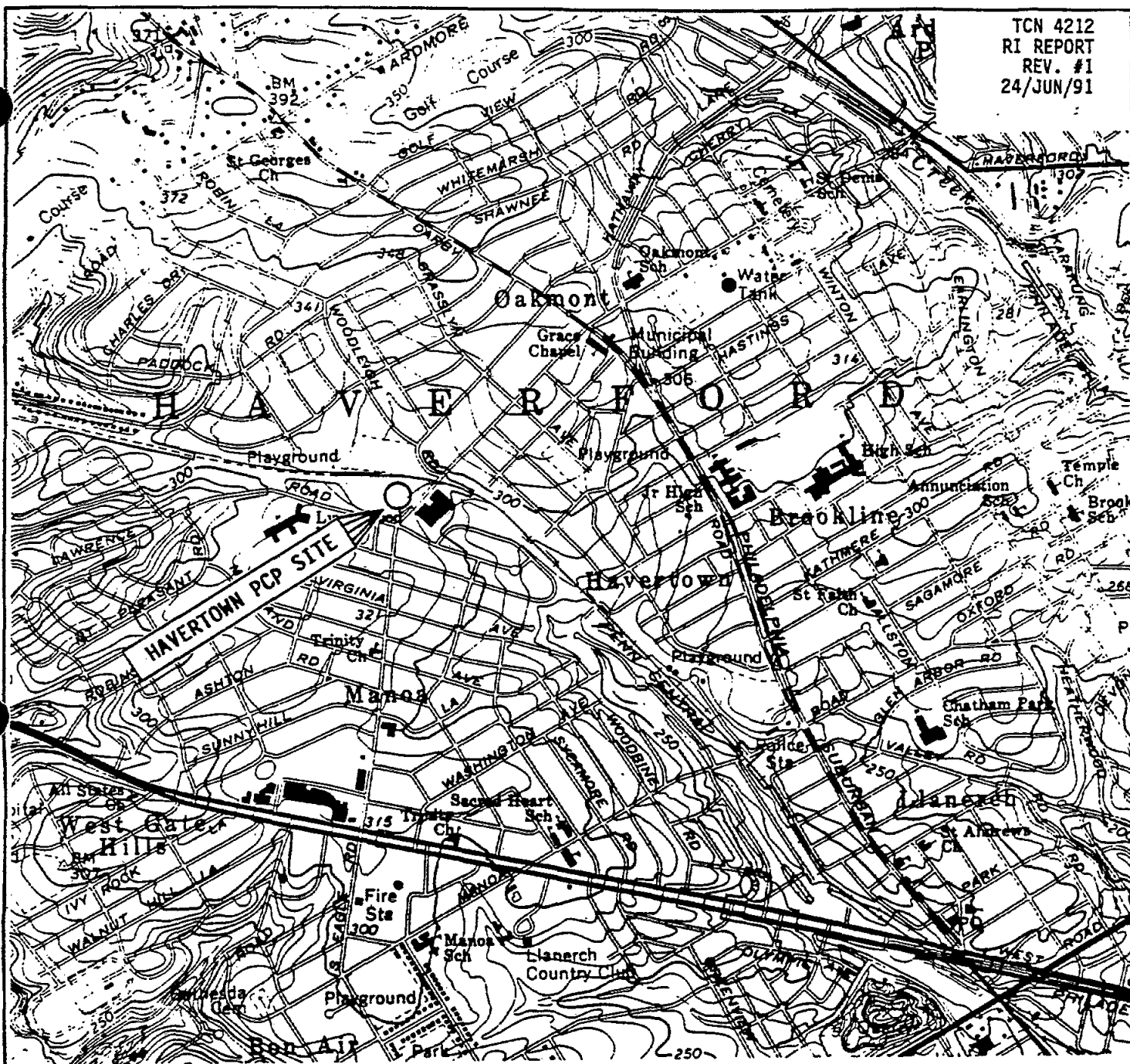
1.2.1 Site Description

The HAVERTOWN site is located in Havertown, Haverford Township, Delaware County, in southeastern Pennsylvania (Figure 1-1). The site is located approximately 10 miles west of Philadelphia and is surrounded by a mixture of commercial establishments, industries, parks, schools, and residential homes.

The HAVERTOWN site covers approximately 12 to 15 acres. It is roughly delineated by Lawrence Road and Rittenhouse Circle to the south, the former Penn Central Railroad (PCRR) tracks to the north, the fence on Continental Motors property to the west, and has no distinctive boundary to the east (Figure 1-2).

The site consists of a number of distinct properties including a former wood-treatment facility owned by National Wood Preservers (NWP), a bubble gum manufacturing plant owned by the Philadelphia Chewing Gum Company (PCG), and neighboring residential and commercial areas. The two-acre NWP property lies

TCN 4212
RI REPORT
REV. #1
24/JUN/91



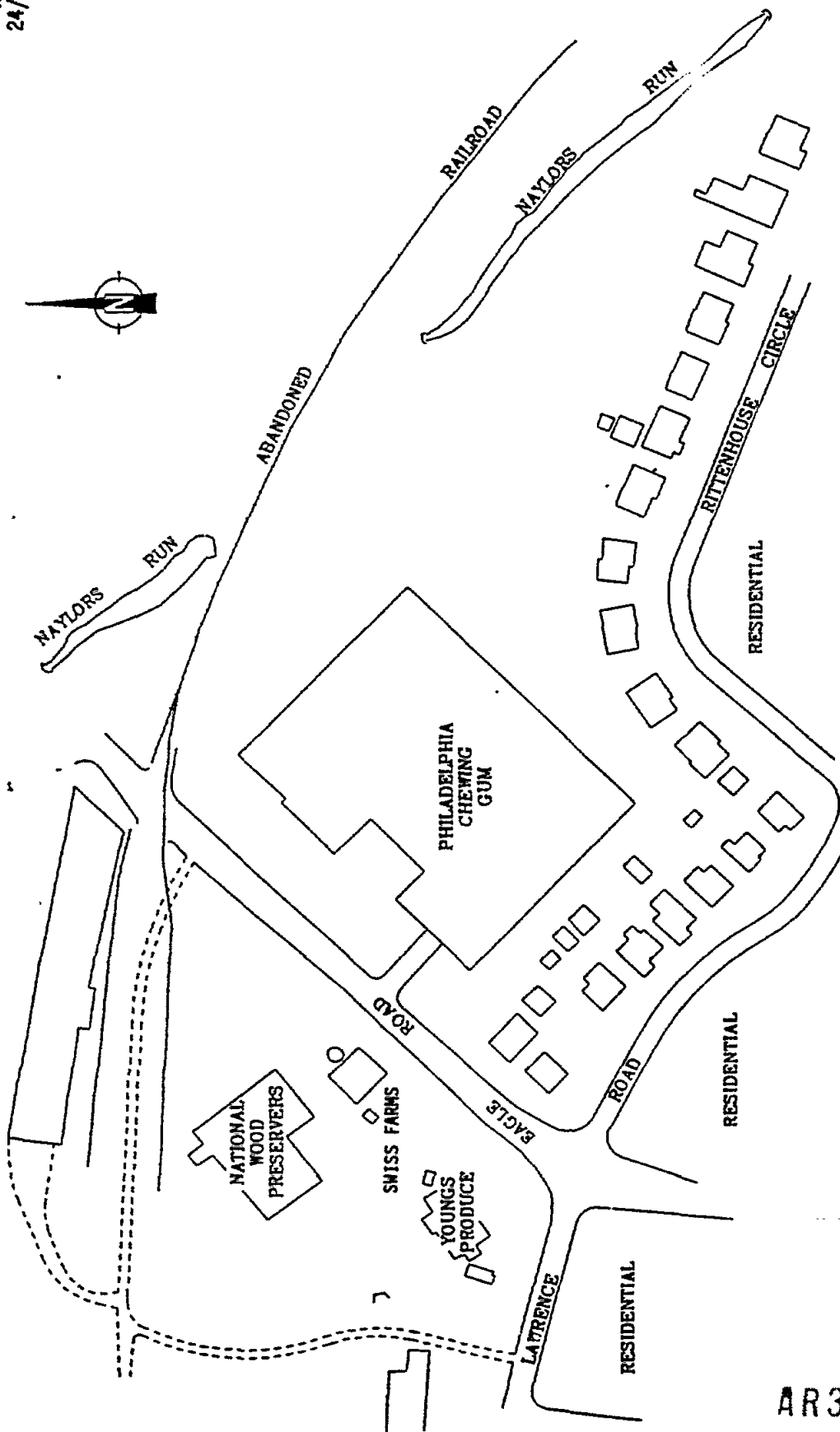
TETRA TECH, INC.

AR300792

**FIGURE 1-1
HAVERTOWN PCP SITE
GENERAL LOCATION MAP**

SOURCE: USGS LANSLOWNE QUADRANGLE, 1973

TCH 4212
RI REPORT
REV. #1
24/JUN/91



TETRA TECH, INC.



**FIGURE 1-2
HAVERTOWN PCP SITE
SITE MAP**

AR300792A

north of the intersection of Eagle Road and Lawrence Road, and is bordered by a chain-link fence. Structures on the NWP property consist of a sheet metal building with multiple above ground chemical storage tanks. The PCG facility consists of a single large bubble gum production building located due east of NWP (northeast of the intersection of Eagle Road and Lawrence Road). The residential areas bordering Rittenhouse Circle and Naylor's Run comprise the remainder of the study area.

1.2.2 Site History

A brief summary of the HAVERTOWN site history is presented below, and an expanded site chronology is contained in Table 1-1 (both from REWAI, 1988).

In 1947, Samuel T. Jacoby obtained a lease from the Clifford Rogers Estate and constructed National Wood Preservers. The facility has not changed significantly since its construction in 1947. The wood preservation practices at the NWP are summarized below.

NWP custom-treats wood as requested by its clients, who supply the materials to be treated. Historically, two wood-treating processes have been used at this facility, the empty cell pressure treatment process and a non-pressure dip treatment. The pressure treatment process was carried out in three pressure treatment cylinders on site. The cylinders are presently empty but have not been cleaned out (Goldstein, 1991). Wood has also been treated by a non-pressure dip method where wood is simply dipped in a tank of treatment solution. After treatment, the wood was allowed to air dry on drip racks.

From 1947 to the present, NWP has used several wood-treating solutions in both their pressure and dip treatment operations. Known chemical solutions include:

- 5% pentachlorophenol (PCP) in a petroleum solvent (P-9 Type A oil, similar to diesel fuel) or a mineral spirits solution (P-9 Type C oil) (1947-1978);
- Tantalithe, also known as Fluoro Chrome Arsenate Phenol (1947- mid 1970's) was replaced by the CCA method;

AR300793

TABLE 1-1
HAVERTOWN PCP SITE
SITE CHRONOLOGY

- 1947: NWP was incorporated by Samuel T. Jacoby. The property on which the plant conducts its business was leased from Clifford and Virginia Rogers.
- 1947-1963: During this period NWP, operated by Mr. Jacoby, allegedly disposed of wood-treatment waste materials into a 25- to 35-foot-deep well, which was said to be located in the vicinity of what is now Young's Produce Market. These wastes generally consisted of spent wood-treatment solutions containing pentachlorophenol (PCP) and oil.
- December 7, 1947: PCG purchases the property located across Eagle Road from NWP and is engaged in the manufacture of chewing gum products.
- 1962: The Pennsylvania Department of Health became aware of contamination in Naylors Run and linked the source to waste disposal practices at the NWP site.
- 1963: NWP changed ownership to Goldstein family. The new owners reportedly discontinued use of the well for disposal practices when they took over the operations.
- December 31, 1964: An agreement was signed between the Goldsteins and Samuel Jacoby which released Mr. Jacoby from responsibility for the pollution.
- February 10, 1967: Shell Oil Company obtained a leasehold interest for the portion of Clifford and Virginia Rogers' property located at the northwest corner of Eagle Road and Lawrence Road. Shell developed this portion of the Rogers' property and constructed a gasoline station at this location (The gas station is no longer present).
- Spring 1972: PCG excavated part of its property in order to construct an addition to its building. During the course of excavation, an oily pollutant was discovered in the ground underlying their property.
- 1972: Commonwealth of Pennsylvania Department of Environmental Resources (DER) received complaints from local citizens concerning an oily substance being discharged into Naylors Run. DER investigated and identified contaminated groundwater discharging from a storm sewer into Naylors Run just east of PCG. DER ordered NWP and Clifford A. Rogers to conduct a cleanup; however, the cleanup was never undertaken.
- June 15, 1972: PCG submitted a report from Site Engineers, Inc. of Morristown, New Jersey. The report considered the cause and source to be pollution entering Naylors Run behind PCG property.
- September 26, 1972: A test well was drilled at NWP by DER with the cooperation of PennDOT. The test well was located along the Eagle Road site of the NWP facility. Upon completion of drilling, water samples were collected and analyzed from this well. The results of this sampling showed PCP in fuel oil to be present in the well. A waste discharge inspection report was filed.
- October 17, 1973: A technical review of pollution at the Havertown PCP site was produced by Ralph V. Zampagna, a geologist from EPA's Groundwater Section Strike Force.
- March 24-25, 1975: A 24-hour stream bioassay was conducted on Naylors Run, the purpose of which was to determine whether toxic concentrations of PCP were present in the organisms in the stream.
- September 17, 1976: EPA declared a Federal Removal Activity for cleanup activities under Section 311 of the Clean Water Act. Cleanup was initiated with installation of filter fences in Naylors Run to remove surface contamination.

TABLE 1-1 (continued)
HAVERTOWN PCP SITE
SITE CHRONOLOGY

- 1976: The EPA Region III Emergency Response Team began cleanup procedures of the area surrounding the NWP facility. A mobile physical-chemical treatment system and mobile spills laboratory were moved to the site. Successful cleanup of the effluent was reportedly accomplished; however, contaminated groundwater continued to leach out.
- November 1-2, 1976: EPA had three recovery wells constructed at NWP by Rulon and Cook, Inc., general Underwater Technics, Inc. The purpose of the wells was to allow pumping of the PCP oil mix to the surface for treatment, after which the treated fluid would be returned to Naylor's Run.
- December 17, 1976: The Environmental Emergency Response Unit operations were secured after it was determined that oil recovery from wells and trenches was not as successful as originally anticipated. USEPA collected approximately 10,000 gallons of contaminated oil.
- February 16, 1977: A meeting was held between DER, EPA, and Underwater Technics to discuss the progress in preventing further discharges to Naylor's Run.
- August 12, 1977: Underwater Technics, Inc. completed the grouting of the 36-inch storm drain.
- February 20, 1978: A report entitled "Laboratory Feasibility and Pilot Plant Studies on Naval Biodegradation Processes for the Ultimate Disposal of Spilled Hazardous Materials" was submitted to EPA by Atlantic Research Corporation. In this study, two pilot-scale batch tests were performed using organism 044 and PCP. The tests were performed in order to evaluate sodium oxide as a potential bacterio-static agent.
- April 20, 1978: Atlantic Research Corporation, under contract to EPA's Oil and Hazardous Materials Spill Branch, conducted preliminary experiments to assess the feasibility of using selected pure cultures to treat the PCP oil contaminated area in Havertown, Pennsylvania.
- August 30, 1978: An aquatic biology investigation was conducted on Cobbs Creek and its tributaries, one of which is Naylor's Run, to determine the extent of water quality.
- January 23, 1981: A plan for monitoring wells was sent to NWP by Mr. James Humphreville, geologic consultant. These monitoring wells were to serve as observation points for determining the lateral extent and thickness of oil floating on the groundwater surface.
- March 1981: The consulting engineering firm of SMC-Martin, Inc., King of Prussia, Pennsylvania, was awarded the EPA contract for an extent of contamination and recovery feasibility study for the PCP oil contamination problem in Naylor's Run.
- April 1981: Preliminary work began on the PCP oil project by SMC-Martin, Inc.
- May 13, 1981: Mr. James Humphreville, geologic consultant, was contracted by NWP to conduct an extent of contamination study on NWP and the remaining Rogers' property.
- June 10, 1981: The Environmental Response Team conducted a biological survey at the site. This study showed that no benthic aquatic life existed up to a distance of one-half mile downstream from the contamination entry points into Naylor's Run. During the study, workers exposed to the vapor emanating from the storm drain while standing on adjacent private property suffered irritation to eyes, skin, and mucous membranes.
- July 27-30, 1981: The SMC Martin, Inc., monitoring well network was drilled. A total of 10 shallow monitoring wells, referred to as HAV-01 through HAV-10, were installed on PCG property and on residential properties along Rittenhouse Circle.
- November 4-6, 1981: Five observation wells were drilled by Thomas G. Keyes, Inc., on the Clifford A. Rogers Estate. Six observation wells were drilled on NWP property.
- March 24, 1982: A public information meeting was held at the Lynnewood School regarding efforts of the EPA and the DER to assess and deal with hazards posed by the release of wood-treatment chemicals in the vicinity of Naylor's Run.

TABLE 1-1 (continued)
HAVERTOWN PCP SITE
SITE CHRONOLOGY

- April 15, 1982: The Emergency Response Team performed a site visit and environmental sampling effort at the NWP site. Samples of air, water, stream sediment, and biota were obtained.
- July 21, 1982: Hazard Ranking System Model was submitted to EPA by Ecology and Environment, Inc., Field Investigation Team (FIT).
- December 1982: The Havertown PCP site, consisting of the NWP plant, was placed on the National Priorities List.
- September 1983: EPA sent a copy of the draft "Remedial Action Master Plan: to DER for their evaluation and comments.
- April 13, 1984: DER letter to EPA concerning upgrading filter fences, limiting access to hazardous areas, and placing more permanent warning signs downstream along Naylor's Run.
- April 25, 1984: Letter from Representative R. W. Edgar to the Community Relations Office DER requesting that DER show its concern for the health and welfare of the Havertown community and rapidly proceed with cleanup operations.
- May 30, 1984: EPA representative noted during a site visit that the filter fences were not operating properly and would have to be reconstructed.
- June 12, 1984: EPA's representative met with a representative of NWP at the site to discuss, in full detail, the reconstruction and maintenance of the filter fences. Shortly thereafter, NWP informed EPA that it had reconstructed the fences.
- September 12, 1984: DER conducted an inspection at the site. The filter fences were clogged; one fence was partially missing; and another was disconnected at one end.
- October 3, 1984: EPA conducted an investigation. Again the filter fences were clogged and in a state of disrepair.
- October 10, 1984: EPA issued a unilateral order pursuant to Section 106 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. 9606 to NWP for proper reconstruction and maintenance of existing filter fences.
- February 1985: DER completes a draft "Community Relations Plan for Remedial action at the Havertown PCP Site."
- February 26, 1985: Public meeting held with DER and area residents concerning cleanup effort at the Havertown PCP site.
- April 17, 1985: EPA site inspection of NWP site. Filter fences saturated and broken.
- April 26, 1985: EPA site inspection of NWP site. Oil still seeping through repaired filter fences. NWP's senior owner expressed his unwillingness to do maintenance more than once daily.
- November 26, 1985: Department of Health and Human Services memorandum stating their opinion that the PCP concentration in the water (at the site) does not present any human health hazard.
- February 26, 1987: DER mails letter to area residents providing notice of a public meeting to be held on March 12, 1987.
- March, 1987: DER sends a consent for right-of-entry form to Conrail, pursuant to a previous telephone conversation.
- April 2, 1987: DER distributes simplified right-of-entry consent forms to area residents.
- June 16, 1987: Gary Moulder (DER) receives notice from Lorna Shull (EPA) that "extensive analysis for dioxin isomers and dibenzofurans will be necessary" at the Havertown PCP site.

TABLE 1-1 (continued)
HAVERTOWN PCP SITE
SITE CHRONOLOGY

- November 10-11, 1987: REWAI conducted a complete round of static groundwater level measurements and product thickness measurements on all existing wells.
- December 12, 14, and 16, 1987: DER and EPA conducted joint sampling of off-site residences and businesses. A total of 59 soil samples were sent to the DER lab in Harrisburg for analysis. EPA began emergency response measures at the site.
- December 21, 1987: Preliminary sample results indicated no detection of PCP in any residential soil samples collected off-site. PCP was detected in the drainage swale and on one spot at Continental Auto.
- December 28, 1987: EPA completed initial work on the underflow dam at the outfall of Naylor's Run. The dam was constructed to provide additional containment of contaminated oil.
- January 18-February 26, 1988: REWAI coordinated and supervised the installation of 6 cluster wells (3 wells per cluster, for 18 total monitoring wells) with Empire Soils Investigations, Inc. of Highland Park, New Jersey, serving as the subcontracted drillers. These wells were installed to aid in determining the extent and nature of contamination at the Havertown PCP site, and to aid in understanding the hydrogeology of the site.
- March 7-18, 1988: REWAI conducted groundwater sampling of all 18 newly installed and 10 selected existing monitoring wells.
- April 11, 1988: REWAI conducted a site visit to collect a sample of the oil for specific gravity measurement and to measure static groundwater levels and oil thickness in all site wells.
- September 1988: Final Remedial Investigation Report Volume I and II for the site was completed by REWAI for DER.
- August 1989: DER approved the Final Focused Feasibility Study for the site that was prepared by REWAI and Lawler, Matusky and Skelly Engineers.
- September 29, 1989: EPA issued a Declaration for the Record of Decision which addresses a NO ACTION for on-site soils, the interim remedial action of installing an oil/water separator at the storm drain effluent to Naylor's Run, and the clean-up of contaminated waste staged on-site. The ROD also states that the potential impact of the soils on the ground water will be addressed during the next operative unit.
- November 15, 1989: EPA issued a Work Assignment for the remedial design of the oil/water separator, and the clean-up of the staged on-site contaminated waste.
- December 5, 1989: EPA issued a Work Assignment for a Remedial Investigation/Feasibility Study to address any potential impact the soils may have on the ground water.

AR300795 A

There are presently eight above-ground storage tanks on site. According to Allen Goldstein, the tanks contain:

- Diluted Chromated Copper Arsenate (CCA) (in use mid 1970's - present);
- Diluted Chromated Zinc Chloride (CZC) (in use mid 1970's - present);
- Diluted PCP.

During the period 1947 to 1963, NWP allegedly disposed of wood-treatment waste materials into a 25 to 35 foot deep well, which was reportedly located in the present vicinity of Young's Produce Market (Figure 1-2). Its exact location is unknown. These wastes generally consisted of spent wood-treatment solutions containing pentachlorophenol (PCP) and diesel-type oil.

In 1962, the Pennsylvania Department of Health became aware of contamination in Naylors Run, a small watercourse located to the east of the site, and linked the source to waste disposal practices at the NWP site. In 1963, Harris Goldstein acquired the operations of the wood-treatment facility and continues to lease the property from the Rogers Estate.

In 1972, the Commonwealth of Pennsylvania Department of Environmental Resources (PADER) received complaints from local citizens concerning an oily substance being discharged into Naylors Run. PaDER investigated and identified contaminated groundwater discharging from a storm sewer into Naylors Run just east of PCG. PADER ordered NWP and Clifford A. Rogers to conduct a cleanup; however, the cleanup was never undertaken.

Since 1972, a number of interim cleanup measures were implemented by the USEPA. The HAVER TOWN site was placed on the National Priority List in 1982. An RI/FS was conducted by W.E. Wright Associates in 1988, resulting in a Remedial Investigation Report (September, 1988) and a Feasibility Study (August, 1989). A Record of Decision (ROD) was issued for the HAVER TOWN site by the USEPA on September 29, 1989, which addressed the cleanup of wastes currently staged on the

site from previous investigative actions, and the interim remedial measure of designing and installing an oil/water separator at the storm drain outlet along Naylor's Run.

The oil/water separator was designed in 1990 and emplaced in Naylor's Run by March 1991. The design criteria were to reduce the oil in the discharge to a concentration of less than 5 mg/l, and to reduce the concentration of volatile organic compounds by 17%. Water from the 30-inch storm sewer discharges into the catch basin, then flows under gravity into the oil/water separator. Evaluation of initial performance testing is in progress.

1.2.3 Previous Investigations

Beginning in 1972, numerous sampling events, which included ground-water, surface-water, soil, air, and biota samples, have been conducted by the Pennsylvania Department of Environmental Resources (PADER), the Pennsylvania Department of Health (PDH), the USEPA, and private consultants (refer to Table 1-1). The following discussion will focus on those investigations relevant to the objectives of this RI; ground water contamination and contamination of Naylor's Run.

The initial sampling was performed in 1972, in response to citizen complaints concerning the discharge of an oily substance from the storm sewer into Naylor's Run. PCP in fuel oil was detected in ground water samples collected from a well drilled on the NWP property by PADER and PennDOT in September of 1972.

PADER Division of Water Quality (Coyne and Sheaffer, 1975) conducted 24 hr. *in-situ* bioassay using Physa sp. snails. 100% mortality occurred in the snails introduced to the surface water of Naylor's Run for 24 hours at all stations except the reference station, which had 0% mortality. The farthest downstream location averaged 0.78 mg/l (parts per million) PCP. Seven (7) taxa were found in Cobbs Creek above the confluence with Naylor's Run. One (1) taxum was found below the confluence in Cobbs Creek. PCP was detected in Cobbs Creek at 5 ug/l (parts per billion [ppb]), suggesting that Cobbs Creek does occasionally receive PCP in concentrations high enough to depress the aquatic community.

Three wells were drilled by the USEPA in 1976 to attempt to recover the PCP-oil product but this effort proved to be largely unsuccessful. Preliminary bioremediation pilot studies were conducted by Atlantic Research Corporation in 1978.

In May 1981, a geologic consultant (James Humphreville) was hired by NWP, at the direction of PADER, to determine the lateral extent and thickness of oil floating on the ground-water surface. Eleven monitoring wells were drilled and installed on the Clifford A. Rogers Estate and the NWP property. Five wells (R-1 to R-5) were drilled on the Rogers estate and six wells (NW-1-81 to NW-6-81) were drilled on the NWP property. The major findings of this investigation were as follows (REWAI, 1988):

- An elongated oil plume trended in an easterly direction from the NWP property. The plume centered around monitoring wells NW-5-81 and R-2.
- Ground water flowed east-southeast from the NWP property towards the PCG property.
- The volume of free recoverable oil present in the ground water was calculated to be 157,600 gallons with an additional 143,400 gallons present in the unsaturated zone.
- Mr. Humphreville proposed that an oil recovery well be installed in the vicinity of monitoring well R-2.

EPA Environmental Response Team (ERT) conducted a nature and extent of contamination study (1981-82) at the Havertown PCP Site. A depressed aquatic community in Naylor's Run was found, showing some recovery from the acute toxicity previously observed. Conservative mathematic modeling demonstrated the potential transport of PCP to the Tinicum Marsh (3.9 ppb) located approximately eight miles southeast of the site. However, at that time it was considered unlikely. Ninety percent (90%) of the PCP was thought to be bound in the sediment being transported down Naylor's Run. Sediment deposited in pools over time could potentially act as a secondary source of contamination.

WH 300798

In 1982, SMC-Martin was awarded an EPA contract to determine the extent of contamination and to perform a feasibility study recovery of PCP-laden oil from Naylor's Run. SMC-Martin designed a monitoring well network of ten wells (HAV-01 to HAV-10) which were installed on PCG property and on residential properties along Rittenhouse Circle. The major findings and conclusions of the investigation were as follows (REWAI, 1988):

- Most ground water occurs in the saprolite or weathered mantle of the Wissahickon Schist.
- The bedrock surface was presumed to be highly irregular due to varying degrees of weathering. Ground-water flow and contaminant migration may be affected by this.
- Ground-water flows primarily to the east and discharges into Naylor's Run.
- The hydraulic gradient was relatively constant, except a low gradient area just east of NWP which was attributed to the presence of fill material.
- Eight monitoring wells (HAV-01, HAV-02, HAV-04, NW-4-81, NW-5-81, NW-3-81, R-2 and R-3) contained measurable oil thickness, with well R-2 containing the greatest thickness (5.60 feet).
- The oil plume was projected as being elliptical in shape, and centered approximately around R-2, with its major axis parallel to the principal ground-water flow direction (easterly).
- The area contaminated by measurable free oil on the ground-water surface was estimated to encompass 4.5 acres.
- The estimated volume of free oil present on the water table surface was 400,000 to 650,000 gallons.

AR300799

- Oil did not appear to migrate past the storm sewer trench behind PCG property; therefore, the storm sewer was believed to act as a conduit for oil migration.

Tetra Tech (1990) collected composite tissue samples of white suckers and black bullheads in Cobbs Creek approximately one mile down stream from the confluence with Naylor's Run. Although the fish tissue was not tested for PCP, significant levels of pentachloroanisole (72.8 and 23.19 ppb) and other chlorinated phenols (ppb range), chlorinated dioxins, and chlorinated dibenzodioxins (parts per trillion range) were detected (Tetra Tech, 1990). Pentachloroanisole and other chlorinated phenols are potential breakdown products of PCP. Dioxins are common contaminants in technical and purified grade PCP (Eisler, 1989).

In 1988, the Remedial Investigation for the Havertown PCP site was performed by R. E. Wright Associates, Inc. REWAI drilled 18 new monitoring wells, performed surface water and sediment sampling in Naylor's Run, surface soil sampling on NWP property, and ground water sampling of 28 monitoring wells. The findings of this investigation included:

- From inspection of historical aerial photographs (1953-1958), the location of Naylor's Run changed during the construction of the Rittenhouse Circle Subdivision. The pre-existing stream channel lies 100 to 130 feet south of its present location. A higher permeability likely exists along this buried stream channel.
- Air sampling results were highly variable and showed no distinct trends.
- Observations made during the drilling program indicated that the bedrock appears highly foliated under the NWP plant and seems less foliated eastward under the PCG plant.
- A significant change in hydraulic conductivity exists in the subsurface between NWP and PCG.
- The bedrock is completely saturated across the site and there were no apparent continuous confining layers.

AK300800

- The horizontal hydraulic gradient under NWP and Rittenhouse Circle areas (0.021 and 0.030 respectively) is higher than the hydraulic gradient under the Swiss Farm Market and PCG building (.007). The overall vertical ground-water gradients found at the site were small compared to the horizontal gradients.
- The highest concentrations of PCP, heavy metals oil and grease, dioxin and dibenzofuran were located in the soil at the chemical storage tank area.
- Solvent/degreaser constituents detected in the ground water near the upgradient well clusters, may originate from a source area west of NWP, since these constituents were never reportedly in use at NWP.
- PCP is the most frequently found contaminant in ground water at the site.
- Dioxin in the ground water appears to be only present in shallow and in some intermediate depth cluster wells (CW-1S, CW-2S, CW-2I, NW-1-81, NW-3-81, R-2, CW-5S, HAV-02, HAV-05, and HAV-07).
- The potential for free-floating immiscible oil, which may be present in the subsurface, is significantly less (estimated at 6,000 gallons) than the 350,000 to 600,000 gallons estimated from previous investigations.
- The migration of the subsurface fuel oil plume may be inhibited near Eagle Road, between NWP and PCG. The cause of this inhibition is not known; however, a stratigraphic oil trap, a structural oil trap, and/or a lithologic change affecting permeability may be responsible.
- Based upon the surface water parameters of dissolved oxygen, pH and specific conductance, water discharged from the storm sewer adversely affects the water quality of Naylor's Run.
- Several Hazardous Substance List metals and Base Neutral Acid extractable compounds detected in the surface water of Naylor's Run could be attributed to activities at NWP.

AR300801

- Sediment samples contained comparatively greater concentrations of the selected dissolved metals than did the surface water samples.
- Significantly greater numbers of BNA compounds were detected in the sediments of Naylor's Run than in the surface water.

On March 28 and 29, 1989, Appalachian Coal Surveys of Pittsburgh, Pennsylvania completed borehole geophysical logging in nine groundwater monitoring wells at the Havertown PCP site under the supervision of REWAI. Natural gamma, high resolution density, formation (gamma-gamma) density, neutron density, and fluid conductivity logs were run on wells CW-4D, R1, R2, R3, R4, R5, NW-1, NW-2, and NW-3. The purpose of these tests was to identify the lithology and relative hydraulic conductivities of the subsurface materials penetrated by the well bore and also to determine well construction features.

The results of the borehole testing (Table 1-2) indicated some divergences from the well construction logs with respect to the position of bentonite seals or thickness of sand pack in most wells. It was also found that wells CW-4, R-5, R-2, and NW-3 appear to be located in areas of relatively higher hydraulic conductivity, while wells NW-1, NW-2, and R-4 are located in areas of relatively lower hydraulic conductivity. Oil product thickness was found to be 10 feet in R-3, 6.5 feet in R-2, and zero in the other wells.

REWAI conducted a two month oil recovery test during the period April 20, 1989 to June 22, 1989 at the Havertown PCP site. The purpose of the test was to determine the potential effectiveness of oil recovery from the groundwater surface. To perform this test an Auto-Skimmer (an automatic oil bailing device) was installed in monitoring wells R-2 and HAV-02. A top-filling bailer was mechanically lowered into the water surface and raised to the surface where the oil was removed from the bailer and stored. This cycle was controlled by preset electronic timers in the device.

In the first two weeks of the test, 56 gallons of oil was recovered from well R-2 and 0.16 gallons was recovered from well HAV-02. No further oil was recovered through the remainder of the test. REWAI attributed the relatively small volume

TABLE 1-2
HAVERTOWN PCP SITE
RESULTS OF BOREHOLE
GEOPHYSICAL LOGGING

Well No.	TD (ft.)	Depth to SWL (ft.)	Product Thickness (ft.)	Saprolite Interval (ft.)	Average Clay Content of Saprolite (%)	Bedrock Interval (ft.)
CW-4D	49	13	0	3 to 26	35	26 to 49
R-1	35	23	0	3 to 32	35	32 to 35
R-2	29	20	6.5	3 to 24	45	24 to 29
R-3	33	23	10	3 to 32	45	32 to 33
R-4	35	21	0	2 to 34	85	34 to 35
R-5	30	24	0	3 to 30	50	--
NW-1	21	13	0	3 to 21	95	--
NW-2	22	13	0	3 to 22	45	--
NW-3	21	8	0	3 to 16	60	16 to 21

TD - total depth
SWL - surface water level
TOC - top of casing
All depths measured from top of casing

Source: R.E. Wright Associates, 1989

AR300803

of oil recovered to well construction characteristics such as bentonite plugging of the screen or gravel pack over time. It was also thought to be likely that the hydraulic conductivity of the aquifer was too low to allow free flow of oil to the well without pumping.

REWAI recommended that ground water pumping of the recovery well be performed in conjunction with the oil recovery test to create a depression of the water table into which oil flow could be induced. The test would require groundwater containment and disposal. Relatively low groundwater yield would be expected due to the low estimated hydraulic conductivity of the formation.

Implementation of this recommendation was not performed. The September, 1989 ROD for the site included provisions for an interim remedial action for the installation of an oil-water separator to address the imminent and continued release of contaminants from the site into the surface water of Naylor's Run.

AR300804

2.0 PHYSICAL CHARACTERISTICS OF STUDY AREA

2.1 DEMOGRAPHY

The Havertown PCP site is predominately comprised of urban and suburban areas in Haverford Township, Delaware County, Pennsylvania. The Havertown PCP site is located in the borough of Havertown, which is centrally located in Haverford Township. Based on the 1990 United States Census Data, 18,210 housing units are occupied by 49,848 people located in Haverford Township.

Land use in Delaware County has been divided into four major categories: urban, agriculture, forest, and other uses. Of these four major categories, "urban" and "other uses" dominate the County, comprising 61% and 24% of the total area, respectively (USDA, 1963). The majority of the eastern half of Delaware County, including the vicinity of the HAVERTOWN site, is an "urban" land use, which consists of residential, commercial, and industrial developments.

2.2 METEOROLOGY

The Havertown site is located in Delaware County, which is typified by a humid, temperate climate. Temperatures average 72° F in the summer months and 32° F in the winter months (USDA, 1963). The Delaware River Basin creates a "storm corridor" along which tropical disturbances and air masses move northward from the Gulf of Mexico or along the Atlantic coastline of the United States (REWAI, 1988). Generally, weather changes every few days in the winter and spring, and less frequently during summer and fall, due to slower atmospheric circulation. Mean annual rainfall is approximately 48 inches; the largest amount of rainfall generally occurs during the growing season, averaging 13.8 inches in summer months, and diminishes to 11 inches over the fall months. Occasional local periods of drought have been known to occur, but humid conditions are the norm. Because of the moderate, moist climate, physical and chemical weathering occur at a moderately rapid rate (USDA, 1963).

AR300805

2.3 GEOLOGY

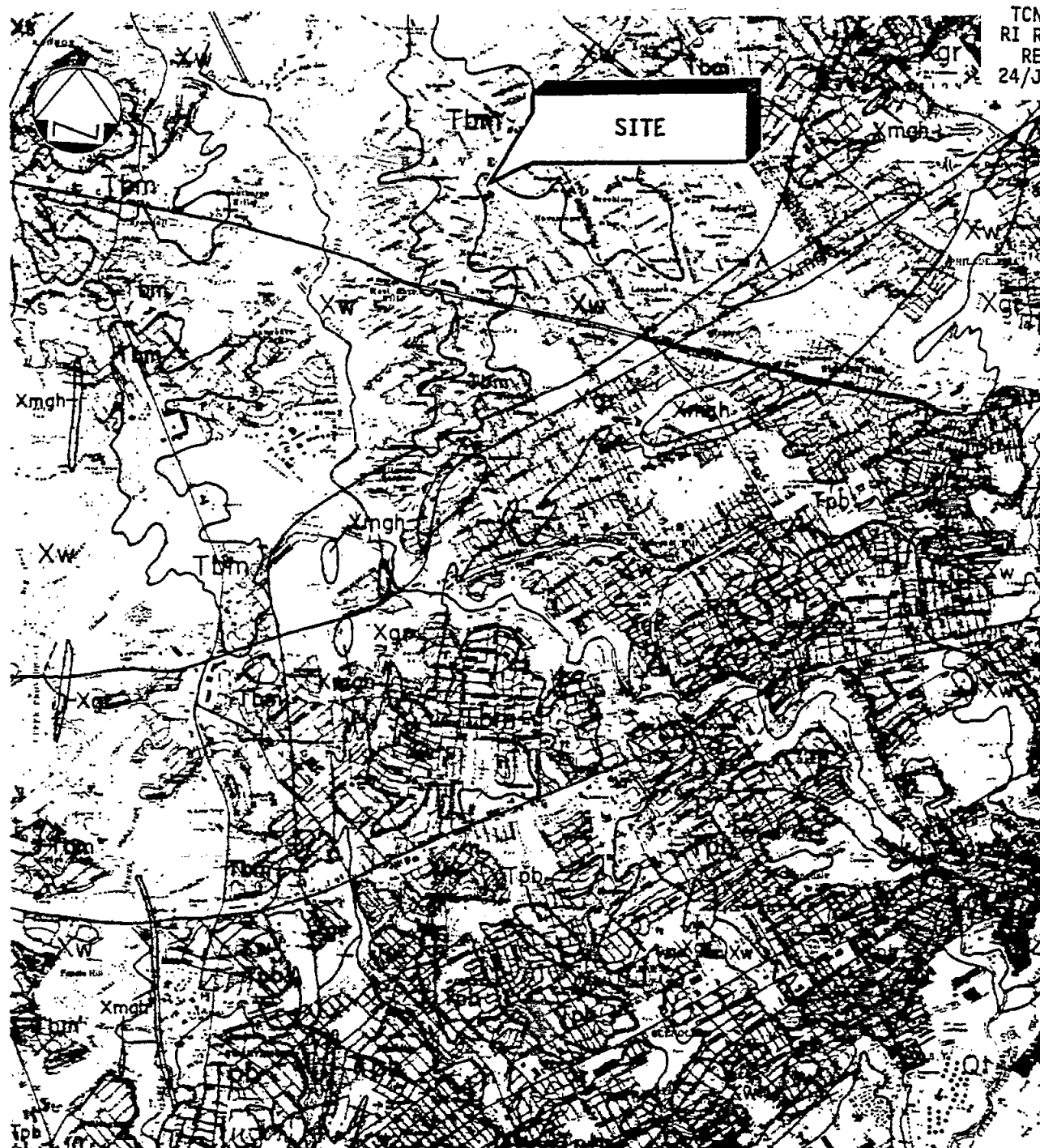
The HAVERTOWN PCP site is located in the Piedmont Uplands section of the Piedmont Physiographic Province, and is characterized by maturely dissected hills sloping gently to the southeast, underlain by a basement of crystalline igneous and metamorphic rocks. The Piedmont Uplands section is the most southerly section of the Piedmont Province in Pennsylvania.

Bedrock in the vicinity of the site consists of metamorphic schist and gneiss of the Wissahickon Formation (Figure 2-1). This formation makes up the majority of the hard rock formation found in the area. The unconsolidated deposits that overlay the bedrock consist of saprolite (in-situ weathered bedrock), sand and gravel terrace deposits, and artificial fill. A generalized cross-section from west to east across the site is presented in Figure 2-2. The location of this line of section is shown in Figure 3-1.

2.4 HYDROGEOLOGY

Ground water at the HAVERTOWN site flows in an easterly direction and occurs in two major zones. The upper zone consists of surficial soils and weathered schist saprolite. The movement of water in the saprolite zone is influenced by the degree of saprolite weathering, relict bedrock structures, compositional variations, and the thickness of the weathered zone (REWAI, 1988). The lower zone consists of highly fractured and jointed schist bedrock, with water movement occurring along interconnected fractures. The bedrock aquifer receives some of its recharge from the downward flow through the overburden aquifer. Upward directed flow also occurs within the overburden aquifer and presumably provides base flow to Naylor's Run. The depth to ground water below the site ranges from approximately 23 feet below ground surface in the vicinity of Youngs Produce Store to approximately 0.5 feet below ground surface in the vicinity of Rittenhouse Circle. At present, neither aquifer is utilized as a source of water supply in the vicinity, as public water is supplied by Philadelphia Suburban Water Company.

AR300806



LEGEND:

- Qt TRENTON GRAVEL
- Tpb PENSAUKEN AND BRIDGETON FORMATIONS
- Tbm BRYN MAWR FORMATION
- Xgr GRANITIC GNEISS AND GRANITE
- Xmgh MAFIC GNEISS
- Xs SERPENTINITE
- Xw WISSAHICKON FORMATION

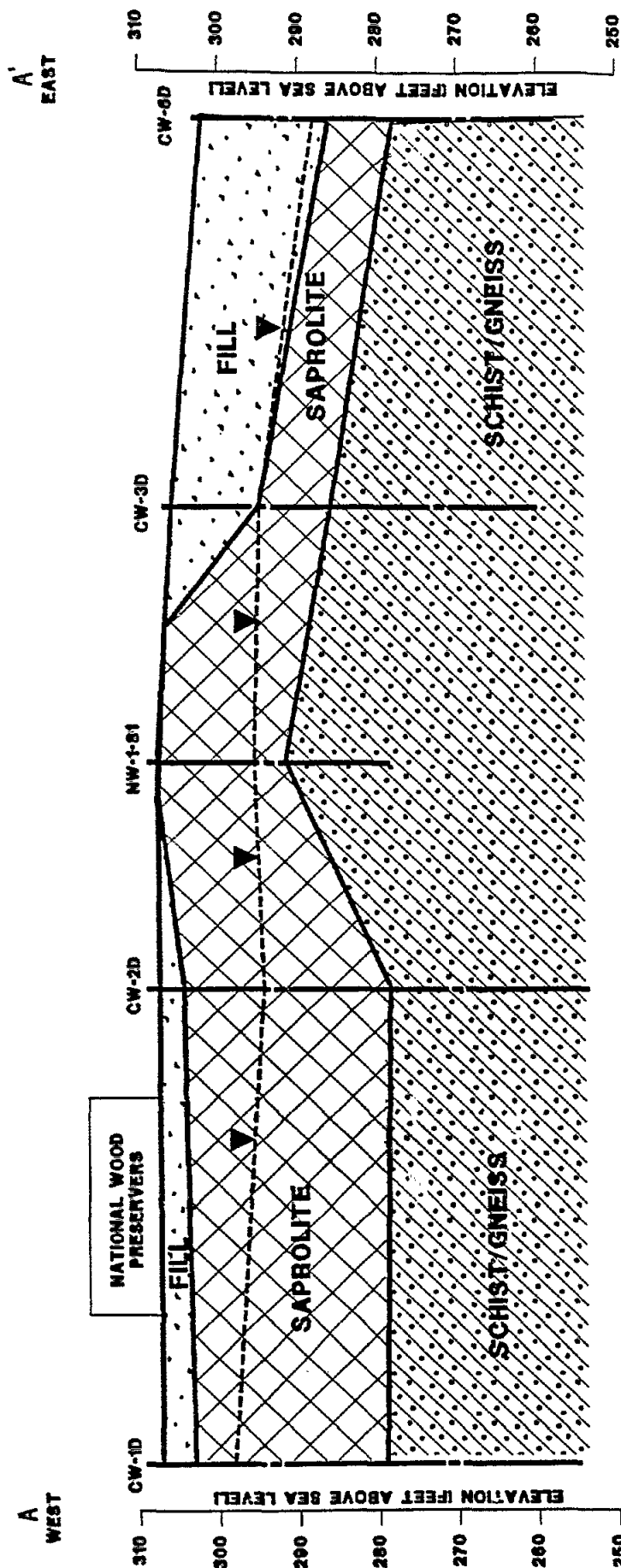
SOURCE: BERG & DODGE 1981,
LANSDOWNE QUADRANGLE



TETRA TECH, INC.

FIGURE 2-1 AR300807
HAVERTOWN PCP SITE
GENERAL GEOLOGIC MAP

TCN 4212
RI REPORT
REV. #1
24/JUN/91



WATER LEVEL MARCH 7, 1990

0 50' 100'
HORIZONTAL SCALE

0 10' 20'
VERTICAL SCALE



TETRA TECH, INC.

FIGURE 2-2
HAVERTOWN PCP SITE
GEOLOGICAL CROSS-SECTION

Adapted from (REWAL, 1988)

AR300808

2.5 PUBLIC WATER SUPPLY

Potable water in the vicinity of the Havertown PCP site is available for use from the Philadelphia Suburban Water Company. The Philadelphia Suburban Water Company obtains water (for Haverford Township) from Pickering Creek, Perkiomen Creek, and from the Schuylkill River. Water is treated at the Pickering Creek Treatment Plant (Figure 2-3) which is located approximately 13.5 miles from the site.

According to the Haverford Township Public Works Department, there is no requirement that residents must hook up to the public water supply system. However, based on Township maps and records, there are no private wells within a 4 mile radius of the Havertown PCP site.

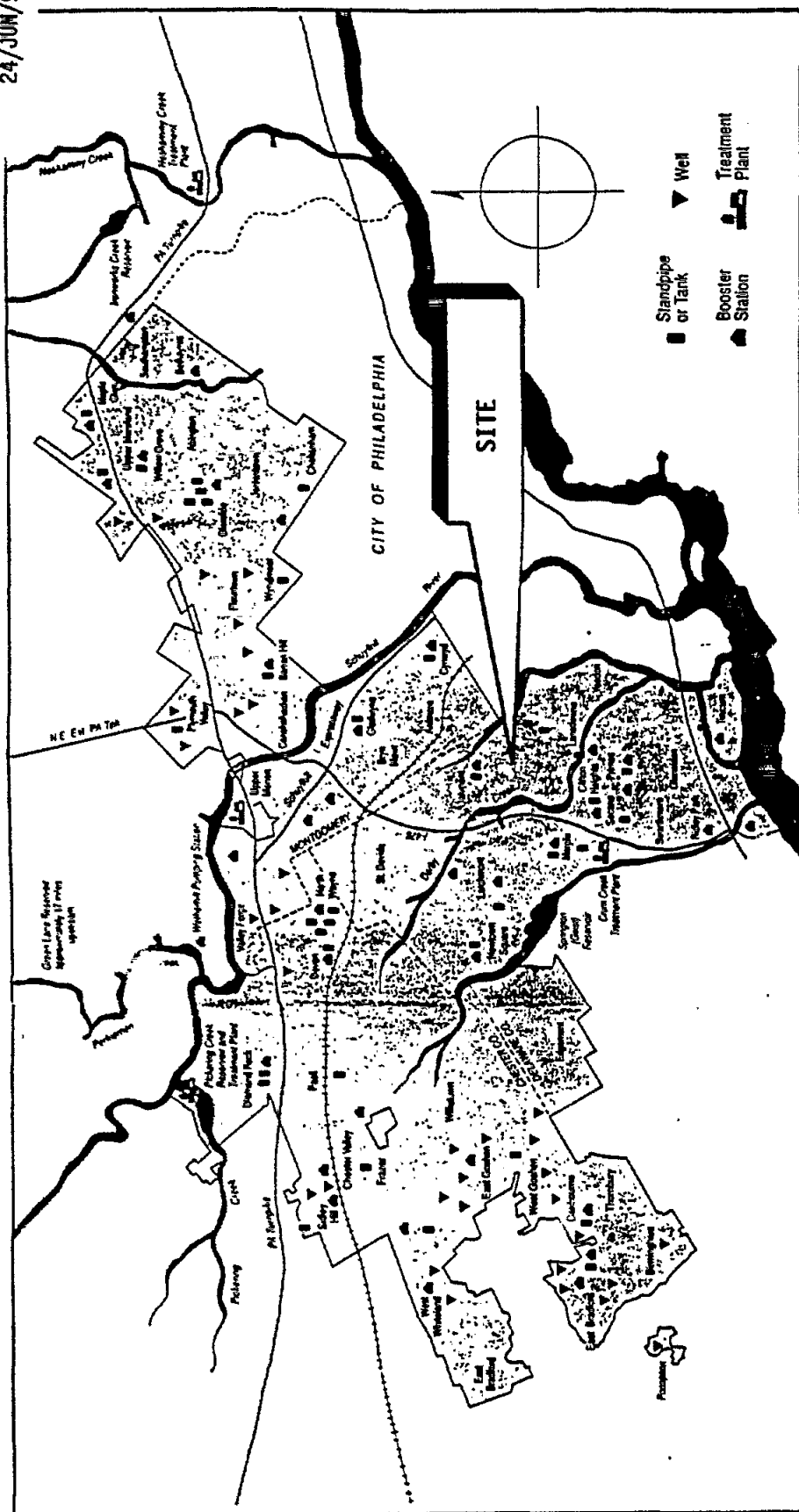
2.6 SURFACE FEATURES

The HAVERTOWN site lies approximately 300 feet above mean sea level. It ranges in elevation from 280 feet above sea level (a.s.l.) in the residential areas along Rittenhouse Circle, to 320 feet a.s.l. northwest of Youngs Produce. The present site topography is a result of major cut and fill alterations to the land. The NWP property is relatively flat, and drains northward toward a drainage ditch that borders the abandoned railroad bed north of the property. The PCG property is also flat, except for a 12-to-15 foot embankment along its southeastern border which separates the PCG property from residential backyards along Rittenhouse Circle. The PCG property drains to the southwest-southeast, towards the residential areas.

2.7 SURFACE HYDROLOGY

The majority of surface runoff across the HAVERTOWN site enters artificial drainage channels, such as storm sewers, before discharging into Naylor's Run. Surface ponding has been observed in selected locations on the NWP property, which either evaporates or infiltrates into the subsurface. During high precipitation events, significant sheet flow has been observed draining towards

TCN 4212
RI REPORT
REV. #1
24/JUN/91



TETRA TECH, INC.



FIGURE 2-3
MAP OF PUBLIC WATER SUPPLY
SOURCES IN VICINITY OF
HAVERTOWN PCP SITE

AR300810

the main gate near Eagle Road before encountering a drainage ditch along the abandoned railroad, which conveys it to Naylor's Run.

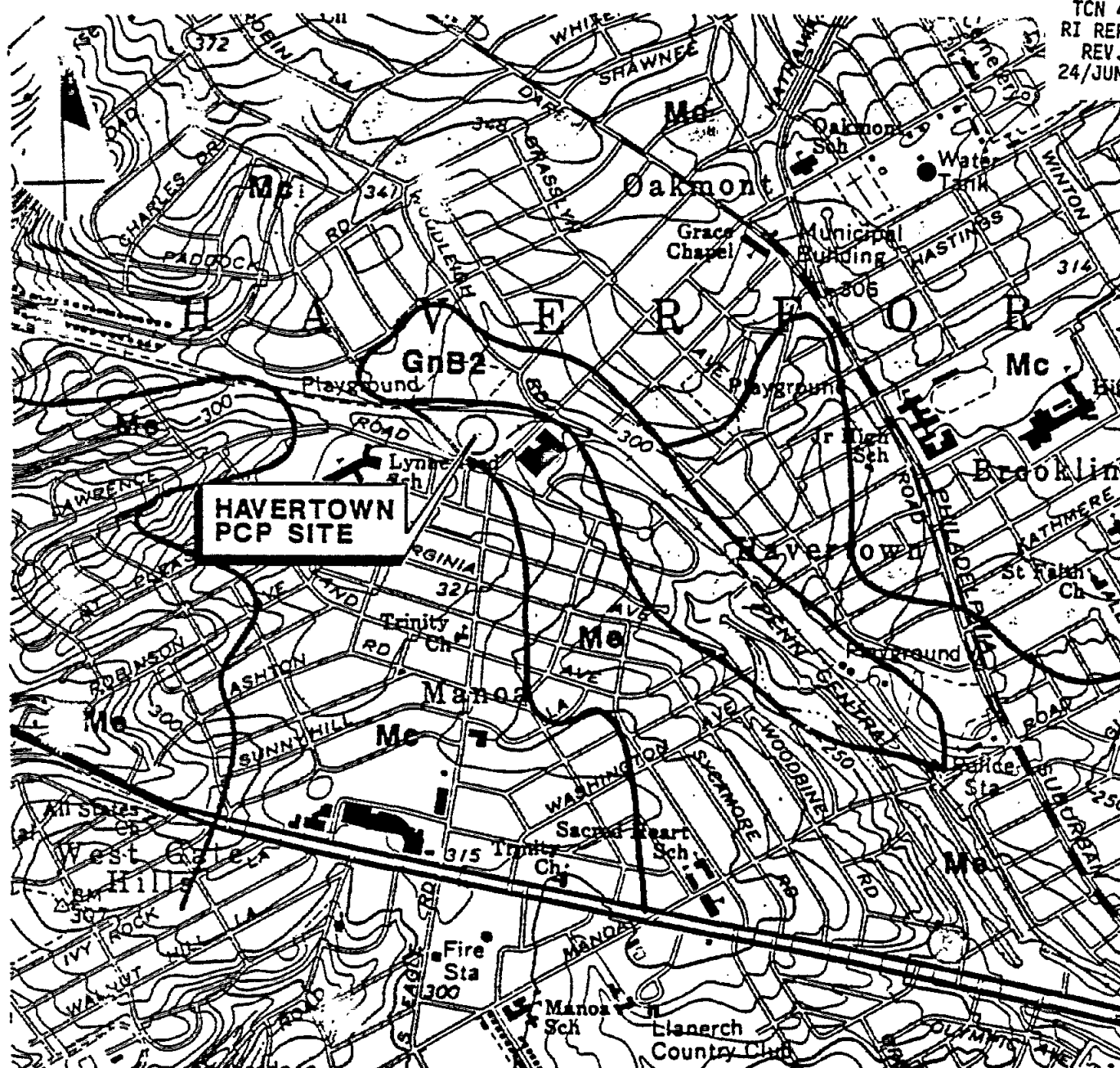
The HAVERTOWN PCP site is drained by Naylor's Run creek, which flows in a southeasterly direction. Naylor's Run receives storm water flow from NWP drainage channels, and storm water collection systems of PCG and Rittenhouse Circle, then flows through a series of natural and concrete lined channels and pipes before entering Cobbs Creek. Channelization and surface runoff subject Naylor's Run to large volumes of water during storm events, resulting in severe stream scouring and erosion in the remaining unchannelized areas. The confluence of Naylor's Run and Cobbs Creek is approximately four (4) miles southeast of the site. Cobbs Creek then joins Darby Creek, and flows through the Tinicum National Environmental Center before discharging into the Delaware River just east of Chester, Pennsylvania.

2.8 SOILS

Based on United States Department of Agriculture (USDA) soil maps, the majority of the soils in the area are classified as Made Land, schist and gneiss materials (Me, Figure 2-4). In this soil classification, the native pedogenic soil profile has been disturbed by earth moving equipment, resulting in a heterogeneous soil mixture of surface material, the subsurface soils, and fragmented partially weathered schist and gneiss rock. A band of Glenville silt loam (GnB2) borders NWP on the north and east. It consists of a moderately eroded soil on 3 to 8% slopes, and develops from weathering of schist and gneiss bedrock (see Section 2.3 - GEOLOGY). The soil profile typically is 3 to 6 feet deep, and has a moderately slow permeability.

2.9 ECOLOGY

The Havertown area is located on a major waterfowl migration route that is part of the Atlantic flyway. Locally, wetlands that serve as resting areas for migrating waterfowl are located in the Tinicum Wildlife Preserve, which lies approximately seven miles southeast of Havertown. Water from Naylor's Run



BASE MAP: FROM LANSDOWNE, PA 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE

(BASED ON USDA, 1963 SOIL SURVEY OF CHESTER AND DELAWARE COUNTIES)

1290' 0 1290'
SCALE IN FEET

LEGEND

Mc MADE LAND (SILT/CLAY)
Me MADE LAND (SCHIST/GNEISS)
GnB2 GLENVILLE SILT LOAM



TETRA TECH, INC.

FIGURE 2-4 AR300812
HAVERTOWN PCP SITE
SOIL MAP

eventually enters this preserve via Cobbs Creek. Cobbs Creek and Darby Creek are listed as warm water fishing streams by the Pennsylvania Fish Commission.

The habitat quality within the study area is considered poor. Urbanization results in constant disturbance, poor natural food source (except for scavengers), and lack of quality cover on made-land soils. Extensive channelization of the run, due to urbanization, has resulted in the degradation of the stream habitat. The Glenville silt loam soils are considered moderate for supporting woodland habitat (USDA, 1963). There are no known undisturbed habitats within the study area.

2.9.1 Study Area Flora

Woodlands - Originally Delaware County consisted of seven forest types: red oak; yellow poplar; sugar maple-beech-yellow birch; black ash-American elm-red maple; pitch pine-Virginia pine; and chestnut-oak. However, commercial cutting, clearing for farm lands, and to a greater extent, urbanization have eliminated any significant woodlands.

The upper section of Naylor's Run bisects an area of Glenville silt loam soils (see Section 2.8 - SOILS). Yellow-poplar, red oak and white oak are native dominant species of this soil type. White pine, larch, Norway spruce and white spruce are typical introduced species found in this soil type. The middle and lower sections of Naylor's Run, as well as the surrounding lands in the study area, consist of man-made soils, which vary in their capabilities to support woodlands.

Crop Lands and Pastures - As mentioned, the study area consists of urbanized lands. No crop lands or natural pastures are present. Small maintained parks are spread throughout the study area, consisting of domestic grasses and weeds interspersed with trees.

AR300813

2.9.2 Study Area Fauna

Terrestrial Fauna - The terrestrial animal population is anticipated to be dominated by domesticated and opportunistic species. Expected mammalian species would include fox squirrel, chipmunk, eastern cottontail, striped skunk, raccoon, Norway rat, house mouse, and short-tail shrew. Homeless pets, such as cats and dogs, may also be present. Year round avian populations of rock dove, mourning dove, European starling, chickadee, cardinal, woodpeckers, sparrows, and finches would be considered common. Occasional migratory insectivores including warblers, flycatchers, and raptors may be seen during various times of the year.

Aquatic Fauna - The aquatic animal population within the majority of Naylor's Run has been documented to be non-existent. The only exception noted was near the confluence with Cobbs Creek, where a stressed aquatic population was documented. Any surviving populations would be expected to consist of tolerant macroinvertebrates such as Chironomids (Dipteran midges).

Cobbs Creek, below the confluence with Naylor's Run, has also been documented (Tetra Tech Inc., 1990) as being impacted by the Havertown PCP Site, but to a lesser degree than Naylor's Run. The extent and severity has not been clearly defined. Cobbs Creek has severe erosion and is expected to have a fair stream habitat. This is evident from previous data (PADER, 1975) where only seven (7) macroinvertebrate taxa were collected from above the confluence with Naylor's Run. A low diversity of Ephemeroptera (mayflies), Trichoptera (caddisflies) and diptera are expected within Cobbs Creek, as well as low populations of cool and warm water fish species such as suckers (Catostomidae) and minnows (Cyprinidae).

2.9.3 Threatened and Endangered Species

Federally Listed Endangered and Threatened Species - A list of Federally Endangered and Threatened Species for Pennsylvania was obtained from the U.S. Fish and Wildlife Service. The Indiana bat (*Myotis sodalis*) and the eastern cougar (*Felis concolor cougar*) are mammalian species listed as endangered. The

eastern cougar is considered by most to be extinct. The Indiana bat predominantly occurs in northeastern Pennsylvania, and is unlikely to occur within the study area. The bald eagle (*Haliaetus leucocephalus*), American peregrine falcon (*Falco peregrinus anatum*), and the arctic falcon (*Falco peregrinus tundrius*) are avian species listed as endangered. The bald eagle and the American peregrine falcon are known to be residential species in Pennsylvania, but are not known to exist within the Havertown PCP Site study area. Pennsylvania is used only as a migratory route for the arctic falcon, and is not used for nesting. No fishes, reptiles, mollusks or plants are listed federally endangered or threatened within the Havertown PCP Site study area.

State Listed Endangered, Threatened, or Species of Concern - The Commonwealth of Pennsylvania is currently revising the state list of Endangered, Threatened, or Species of Concern. This list is not available until the revision is complete.

The bog turtle (*Clemmys muhlenbergii*) has had past sightings in Darby Creek, located east of the study area. The bog turtle has been listed as "Endangered" by the State. There is no recent confirmation of its presence within the area.

The elephant's foot (*Elephantopus carolinianus* Raeusch) is a plant species that the State has listed, or that has been recommended to the State to be listed, as "Rare". The elephant's foot is a woodland species that may potentially exist near the study area, but has not been identified as present.

Three plant species are listed by the State as "Tentatively Undetermined", meaning that their status regarding endangerment classification has not been determined. The pipevine (*Aristolochia macrophylla* Lam.) and the ellisia (*Ellisia nyctelea* L.) are woodland species found near stream banks. Midland sedge (*Carex mesochorea* Mackenzie) is a plant of dry open woods. These species have not been identified to occur within the study area.

AR300815

3.0 STUDY AREA FIELD INVESTIGATIONS

This portion of the report describes the field investigation performed for the HAVERTOWN RI/FS. There were four (4) major elements of the field investigation; investigation of ground water, investigation of Naylor's Run and Cobbs Creek, investigation of the storm sewer running from Rittenhouse Circle to Naylor's Run, and investigation of the local ecology.

The ground-water investigation consisted of six (6) measurement events of water levels and free product thickness over a seven (7) month period, and two (2) rounds of ground-water sampling from 28 monitoring wells. The investigation of Naylor's Run and Cobbs Creek consisted of collecting 11 sediment and 10 surface water samples. The investigation of the storm sewer included a video inspection of the sewer and collection of 3 water and 2 sediment samples. The ecological investigation included examination of the flora and fauna immediately adjacent to Naylor's Run and Cobbs Creek at 4 locations. The sampling was performed during the period August, 1990 to January, 1991.

All sample collection, sample handling, and equipment decontamination procedures have been previously described in detail in Tetra Tech's Field Sampling Plan and Quality Assurance Plans submitted for the site. Therefore, these above-mentioned procedures are only briefly discussed in the following presentation.

3.1 GROUND-WATER INVESTIGATION

3.1.1 Measurement of Ground-Water Level and Free Product Thickness

Purpose and Scope - Ground-water levels and free product thickness were measured once a month from August, 1990 to March, 1991 in 28 of the existing wells (Figure 3-1). The objective of measuring the ground-water levels was to evaluate horizontal and vertical flow gradients in the shallow and deep hydrologic zones. Additionally, current water level information was used to assess the extent of seasonal fluctuation of the water table. The objective of measuring the free product thickness is to update previous estimates of the horizontal extent and total volume of free product (REWAI, 1988).

AR300816

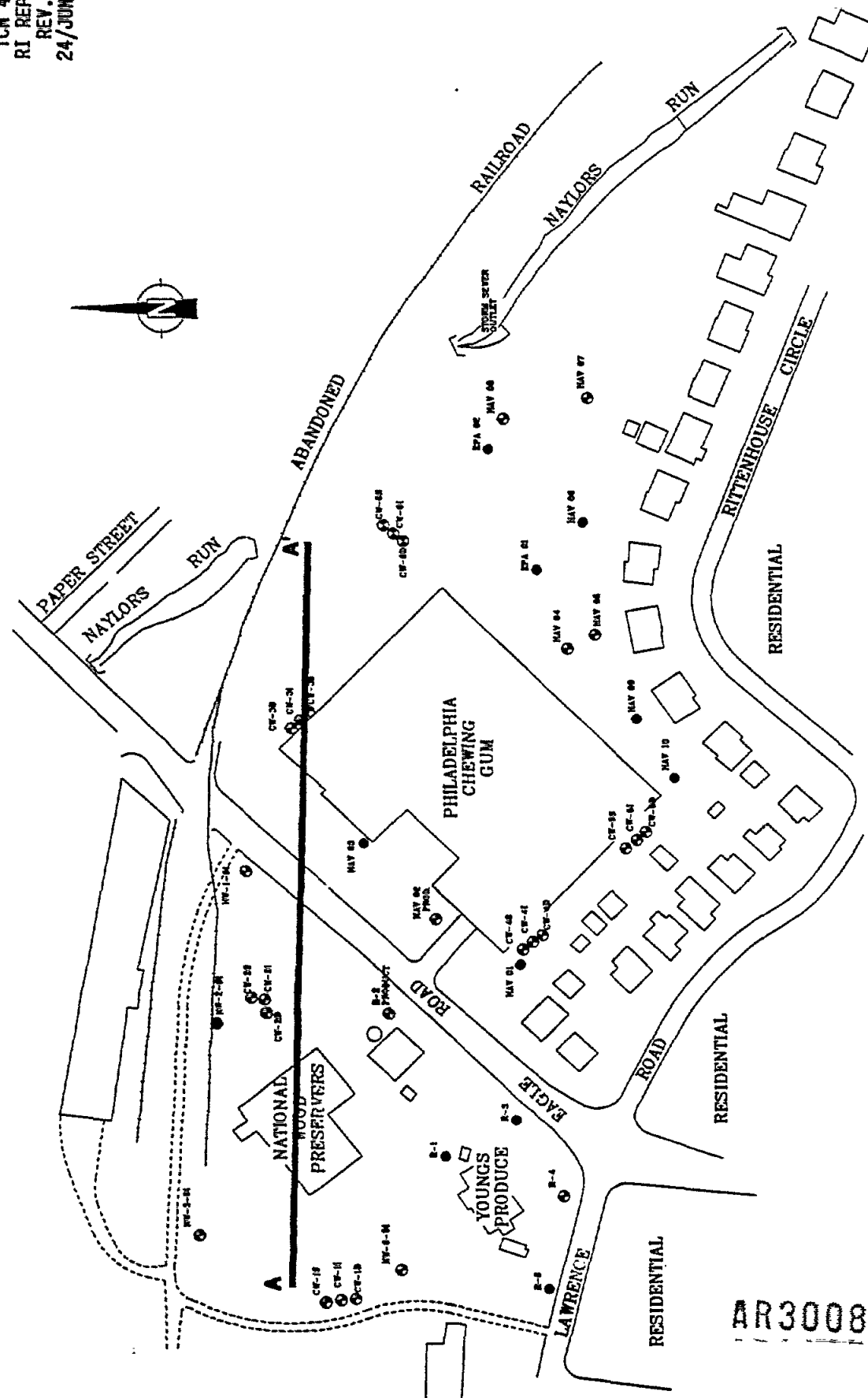


FIGURE 3-1
HAVERTOWN PCP SITE
WELL LOCATION MAP

LEGEND:
● MONITORING WELL LOCATIONS SAMPLED
● OTHER MONITORING WELL LOCATIONS
A-A' LINE OF CROSS SECTION IN FIGURE 2-2

AR300817

Methodology - Depth to water from the top of the well casing and free product thickness were measured using an Oil Recovery System (ORS) oil/water interface probe. The measurements were converted to a common datum (mean sea level) using the surveyed elevations of each well. None of the measurements were taken at the same time as a ground water sampling event.

3.1.2 Ground-Water Sampling

Purpose and Scope - Ground-water samples were collected in two rounds of sampling (August 20-30, 1990 and November 7-15, 1990) from 28 wells around the site that had been installed during previous investigations (Figure 3-1). The 28 wells were sampled to update information obtained in 1988 regarding the extent and magnitude of contamination in the ground water. Of the 28 wells, 18 wells are screened in the fill and/or saprolite, 2 wells are screened across the weathered rock zone (saprolite) and the 8 bedrock wells are screened in the bedrock only (Table 3-1). For the purpose of this report, the 18 wells screened in the saprolite/fill represent the shallow hydrogeologic zone and the 10 wells screened across the saprolite/bedrock interface or in bedrock only represent the deep hydrogeologic zone. All wells kept the designations given in previous investigations.

Methodology - The following procedures were followed to perform the sampling: Prior to sampling, all wells were measured for the presence of organic vapors using a Photoionization Detector (PID). A water level probe was then used to measure the water level, and water volume in the well was calculated using total well depth and the well casing diameter. Depending upon the total volume to be purged, either a 2" KVA Model XP100-60 submersible pump or a 1-5/8" outside diameter stainless steel bailer was used to purge the wells. The KVA pump purges at a rate of approximately 1.5 gallons per minute. The pump was lowered to approximately two feet above the well bottom and secured. Pumping commenced and continued until conductivity, temperature and pH readings stabilized and/or a minimum of three well volumes were purged from the well. Well purging information for round 1 and round 2 of the ground-water sampling is given in Table 3-2 and Table 3-3, respectively.

AR 500818

Table 3-1
Havertown PCP Site
Summary of Monitoring Well Construction

WELL	TOTAL DEPTH (ft)	WELL DIAMETER (inches)	CASED INTERVAL (ft)	SCREENED INTERVAL (ft)	DEPTH TO BEDROCK (ft)	LITHOLOGIC UNIT SCREENED
CW-1D	51.3	2	0-41.3	41.3-51.3	28.8	Biotite-Muscovite Schist (R)
CW-2D	54.1	2	0-46.0	46.0-54.1	29.9	Biotite-Muscovite Schist (R)
CW-3D	46.0	2	0-36.0	36.0-46.0	20.0	Biotite-Gneiss (R)
CW-4I	35.0	2	0-25.0	25.0-35.0	28.0	Biotite-Quartz-Feldspar Gneiss (S & R)
CW-4D	50.0	2	0-40.0	40.0-50.0	28.0	Biotite-Quartz-Feldspar (R)
CW-5I	31.0	2	0-21.0	21.0-31.0	18.4	Biotite-Quartz-Feldspar Gneiss (R)
CW-5D	46.0	2	0-36.0	36.0-46.0	18.3	Biotite-Quartz-Feldspar (R)
CW-6I	34.5	2	0-27.0	27.0-34.5	24.5	Biotite-Gneiss (R)
CW-6D	48.5	2	0-38.5	38.5-48.5	24.5	Biotite-Gneiss (R)
NW-1	26.0	4	NO LOG AVAILABLE			(S & R)
CW-1I	28.0	2	0-18.0	18.0-28.0	-	Silty Sand (S)
CW-2I	30.0	2	0-20.0	20.0-30.0	30.0	Silty Sand (S)
CW-3I	20.0	2	0-15.0	15.0-20.0	20.0	Biotite Schist Sapolite (S)
R-2	29.0	4	NO LOG AVAILABLE			(S)
R-4	33.0	4	NO LOG AVAILABLE			(?)
NW-3	24.0	4	NO LOG AVAILABLE			(?)
NW-6	24.0	4	NO LOG AVAILABLE			(S)
CW-1S	16.2	2	0-6.2	6.2-16.2		Silty Sand (S)
CW-2S	15.0	2	0-5.0	5.0-15.0		Silty Sand (S)
CW-3S	16.5	2	0-6.5	6.5-16.5		Biotite Schist Sapolite (F & S)
CW-4S	23.0	2	0-8.0	8.5-23.0		Medium Grained Sand (S)
CW-5S	18.0	2	0-8.0	8.0-18.0		Silty Sand (S)
CW-6S	24.5	2	0-8.0	8.0-24.5		Micaceous Sand (F & S)
HAV-02	28.3	2	NO LOG AVAILABLE			(F & S)
HAV-04	6.0	2	NO LOG AVAILABLE			(F & S)
HAV-05	11.5	2	NO LOG AVAILABLE			(F & S)
HAV-07	11.0	2	NO LOG AVAILABLE			(F & S)
HAV-08	11.0	2	NO LOG AVAILABLE			(F & S)

(F) - Fill (R) - Rock (S) - Sapolite

Note: All wells above the double line represent the deep hydrogeologic zone; those below represent the shallow hydrologic zone.

TABLE 3-2
HAVERTOWN PCP SITE
GROUND WATER SAMPLING
ROUND 1
AUGUST 21-30, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

Well	Diameter (inches)	Volume Purged (gallons)	Method of Purging	Avg. pH (units)	Avg. Temp. (°C)	Avg. Cond. mhos/cm
1. HAV-07	2	3	Pump	7	18	448
2. HAV-08	2	2.5	Bailer	6	17	470
3. CW-5D	2	22	Pump	6.36	16	342
4. CW-5I	2	17	Pump	6.07	16	329
5. CW-5S	2	21	Pump	5.94	17	302
6. HAV-05	2	4	Bailer	5.61	22	104
7. HAV-04	2	1	Bailer	-	Product	-
8. CW-4D	2	20	Pump	5.86	20	412
9. CW-4I	2	12	Pump	5.84	20	415
10. CW-4S	2	7.5	Pump	5.54	22	422
11. CW-6D	2	16.5	Pump	5.95	18	858
12. CW-6I	2	14	Pump	5.73	18	803
13. CW-6S	2	5	Bailer	6.52	18	1685
14. CW-3D	2	19	Pump	5.94	18	631
15. CW-3I	2	4	Bailer	6.20	18	753
16. CW-3S	2	3	Bailer	5.83	18	529
17. NW-1-81	4	31.5	Pump	5.69	21	277
18. CW-2D	2	21	Pump	5.12	19	487
19. CW-2I	2	10	Pump	4.63	17	339
20. CW-2S	2	1	Bailer	4.30	18	317
21. NW-3-81	4	40	Pump	5.21	17	117
22. CW-1D	2	21	Pump	5.89	16	80
23. CW-1I	2	10	Pump	5.92	17	77
24. CW-1S	2	8	Pump	5.52	19	144
25. NW-6-81	4	20	Pump	5.74	15	111
26. R-4	4	30	Pump	4.85	16	83
27. HAV-02	2	7	Pump	5.62	19	517
28. R-2	4	15	Bailer	-	Product	-

Legend: (-) No Data

AR300820

TABLE 3-3
HAVERTOWN PCP SITE
GROUND WATER SAMPLING
ROUND 2
NOVEMBER 7-15, 1990

TCN 4212
RI REPORT
REV. #1
24/JUN/91

Well	Diameter (inches)	Volume Purged (gallons)	Method of Purging	Avg. pH (units)	Avg. Temp. (°C)	Avg. Cond. mhos/cm
1. HAV-07	2	4	Bailer	6.39	15	218
2. HAV-08	2	3	Bailer	5.67	15	365
3. CW-5D	2	18	Pump	6.79	14	272
4. CW-5I	2	10	Pump	6.33	14	280
5. CW-5S	4	6	Pump	6.06	15	222
6. HAV-05	2	4	Bailer	6.5	14.5	198
7. HAV-04	2	1	Bailer	-	Product	-
8. CW-4D	2	18.5	Pump	6.12	14	279
9. CW-4I	2	11	Pump	5.93	15	237
10. CW-4S	2	5	Pump	5.43	14	250
11. CW-6D	2	16	Pump	5.81	15	298
12. CW-6I	2	9	Pump	6.05	15	339
13. CW-6S	2	4	Bailer	6.89	16	732
14. CW-3D	2	17	Pump	5.55	14	249
15. CW-3I	2	4	Bailer	6.11	15	295
16. CW-3S	2	2	Bailer	5.71	16	289
17. NW-1-81	4	26	Pump	6.53	15	139
18. CW-2D	2	20	Pump	5.53	16	192
19. CW-2I	2	8	Pump	4.86	13	196
20. CW-2S	2	1	Bailer	4.95	16	222
21. NW-3-81	4	28	Pump	5.48	12	359
22. CW-1D	2	21	Pump	6.71	11	-
23. CW-1I	2	9	Pump	6.10	13	-
24. CW-1S	2	3	Bailer	5.88	13	-
25. NW-6-81	4	28	Pump	6.18	14	-
26. R-4	4	25	Pump	-	-	-
27. HAV-02	4	7	Bailer	-	Product	-
28. R-2	4	18	Bailer	-	Product	-

Legend (-) No Data

AR300821

All purged water was discharged directly to the catch basin at Naylor's Run at the direction of the USEPA. All purged waste oil was collected in 55-gallon drums for later analysis and disposal.

Bailers and pumps used in purging were decontaminated after each use. However, pump tubing was dedicated to each well sampled.

Ground-water samples were collected using a stainless steel bailer. All samples were collected immediately after well purging or within 24 hours of purging in cases where wells were purged dry. Prior to sample collection, all bailers were thoroughly decontaminated. Sample bottles were filled directly from the bailer with as little agitation as possible. Ground-water samples to be analyzed for volatile organic compounds were collected first and preserved with hydrochloric acid. Ground-water samples receiving analysis of dissolved metals were filtered through a 0.45 micron filter and preserved with nitric acid. Ground-water samples receiving analysis of cyanide were preserved with sodium hydroxide.

Samples collected during the first round of sampling (August 20-30, 1990) were sent to CLP laboratories for analysis of Target Compound List (TCL) organic and Target Analyte List (TAL) inorganic compounds. Samples collected during the second round of sampling (November 7-15, 1990) were sent to CLP laboratories for analysis of TCL organic compounds and TAL inorganic compounds, as well as dioxin, dibenzofuran, and their isomers.

3.2 INVESTIGATION OF NAYLOR'S RUN AND COBBS CREEK

Purpose and Scope - The sampling of surface water and sediment in Naylor's Run and Cobbs Creek was performed primarily to determine the present level of contaminants in these streams and to assess whether the contamination posed a risk to either human health or the environment. The results of the sampling were also utilized to assess whether contamination levels were reduced following the installation of the catch basin by the USEPA.

Surface water and sediment samples were collected from six (6) locations in Naylor's Run in September 1990. All surface water samples were given the prefix

"NAY-AQ" and all sediment samples were given the prefix "NAY-SED." Both surface water and sediment samples were collected from stations 01, 02, 03, 04, and 06. Only a sediment sample was available at station 05. The aqueous sample was actually collected from a seep located on the east bank of Naylor's Run south of Eagle Road. Sample locations are depicted in Figure 3-2.

In January, 1991, five (5) additional sediment and surface water sample pairs were collected from locations downstream of the samples collected in September, 1990. These additional samples were collected from Naylor's Run at stations 08, 09, and 10. Two (2) samples were collected from Cobbs Creek (Figure 3-2), and were designated COBB-AQ-01 and -02, and COBB-SED-01 and -02, respectively.

Sample stations 01 through 06 were collected from the portion of Naylor's Run closest to National Wood Preservers. Station 06 is located immediately adjacent to Eagle Road. Station 04 is located immediately outside the catch basin while station 03 is located inside the catch basin. Station 02 is located just upstream of the point that the channel is lined with concrete, approximately 250 feet downstream of the catch basin. Station 01 is located at the end of Virginia Avenue in a natural section of channel.

Station 08 is located close to Station 01 for the purpose of quality assurance. Station 09 is located just downstream of the point where an unnamed tributary enters Naylor's Run. This unnamed tributary receives runoff from a nearby golf course and rock quarry. Station 10 is located approximately 2 miles upstream of the confluence of Naylor's Run and Cobbs Creek. Station 01 in Cobbs Creek is located below the mixing zone of the confluence of Naylor's Run and Cobbs Creek. Station 02 in Cobbs Creek is located upstream of the confluence of Naylor's Run and Cobbs Creek, and serves as a reference station.

Methodology - At each sampling location (shown in Figure 3-2), the surface water sample was collected first, followed by the collection of the sediment sample. This was done in order to minimize agitation of the sediment and re-suspension into the water column. Sampling occurred from downstream to upstream in areas characterized by a steady, non-turbulent, flow of water. Surface water samples were collected using a decontaminated, 32-ounce, stainless-steel pitcher. Field

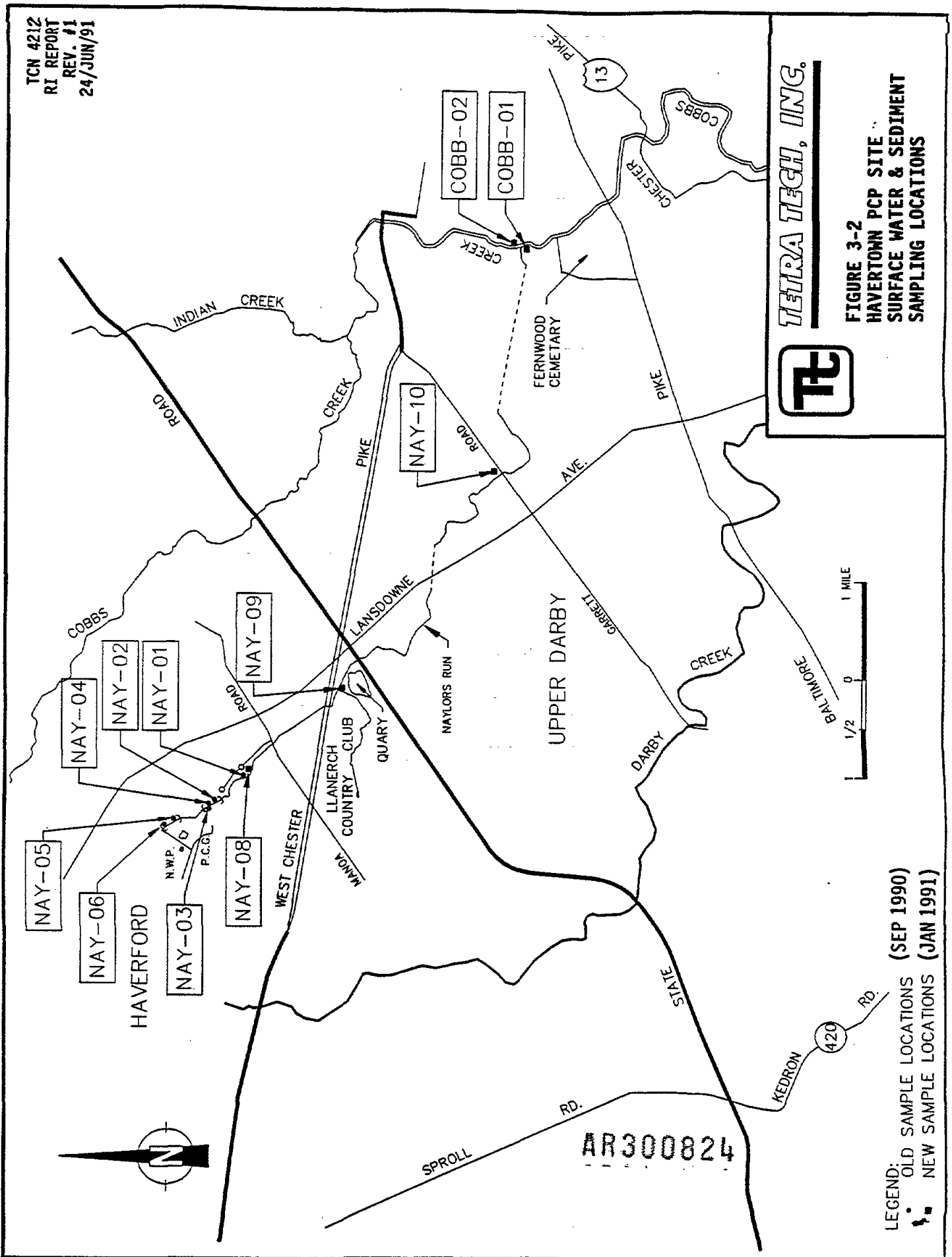
TCN 4212
RI REPORT
REV. #1
24/JUN/91

TETRA TECH, INC.



FIGURE 3-2
HAVERTOWN PCP SITE
SURFACE WATER & SEDIMENT
SAMPLING LOCATIONS

LEGEND:
● OLD SAMPLE LOCATIONS (SEP 1990)
■ NEW SAMPLE LOCATIONS (JAN 1991)



measurements of pH, specific conductance, and temperature were obtained for each sample.

Sediment samples were collected from depths of 0 to 6 inches at the same localities as the surface water samples except Location #5, which was the seep sample location. Sediment samples were collected from areas of stream bottom where the finest-grained sediments were located. A stainless-steel scoop was used to collect the sediment sample, then the scoop was decontaminated between each sampling location.

The samples collected from stations NAY-01 through 06 in September, 1990 were submitted to CLP laboratories for analysis of TCL organic compounds, TAL inorganic compounds (total metals and cyanide), and dioxin, dibenzofuran, and their other isomers. Additionally, samples from stations 01, 02, 04, and 06 were analyzed for grain size.

The samples collected from stations NAY- 8, 09, and 10 in Naylor's Run and stations COBB-01 and 02 were submitted to CLP laboratories for analysis of TCL semi-volatile organic compounds, total organic carbon, and grain size.

3.3 STORM SEWER INVESTIGATION

3.3.1 Water and Sediment Sampling

Purpose and Scope - Storm water and sediment samples were collected in September 1990 in the catch basin/manholes of the two existing storm sewer systems located in the backyards of the residents along Rittenhouse Circle and in the north parking lot of the PCG facility. The storm sewers were sampled in an attempt to determine whether contaminants transported to Naylor's Run via the storm sewer were entering the sewer from surface water or from ground-water sources. Samples were designated "SS-AQ" and "SS-SED" for storm sewer water samples and storm sewer sediment samples, respectively.

The initial scope of work for the sewer sampling, as described in the Field Sampling Plan, designated four locations to be sampled for both storm water and

AR 000825

sediment (Figure 3-3). However, due to the absence of water, storm water samples were not taken at stations 01 and 03. Due to the absence of sediment, sediment samples were not taken at stations 01, 02, and 03. A fifth sampling point, located in the drainage swale adjacent to National Wood Preservers, was added with USEPA approval. However, only a sediment sample was collected because of the absence of water at this locality.

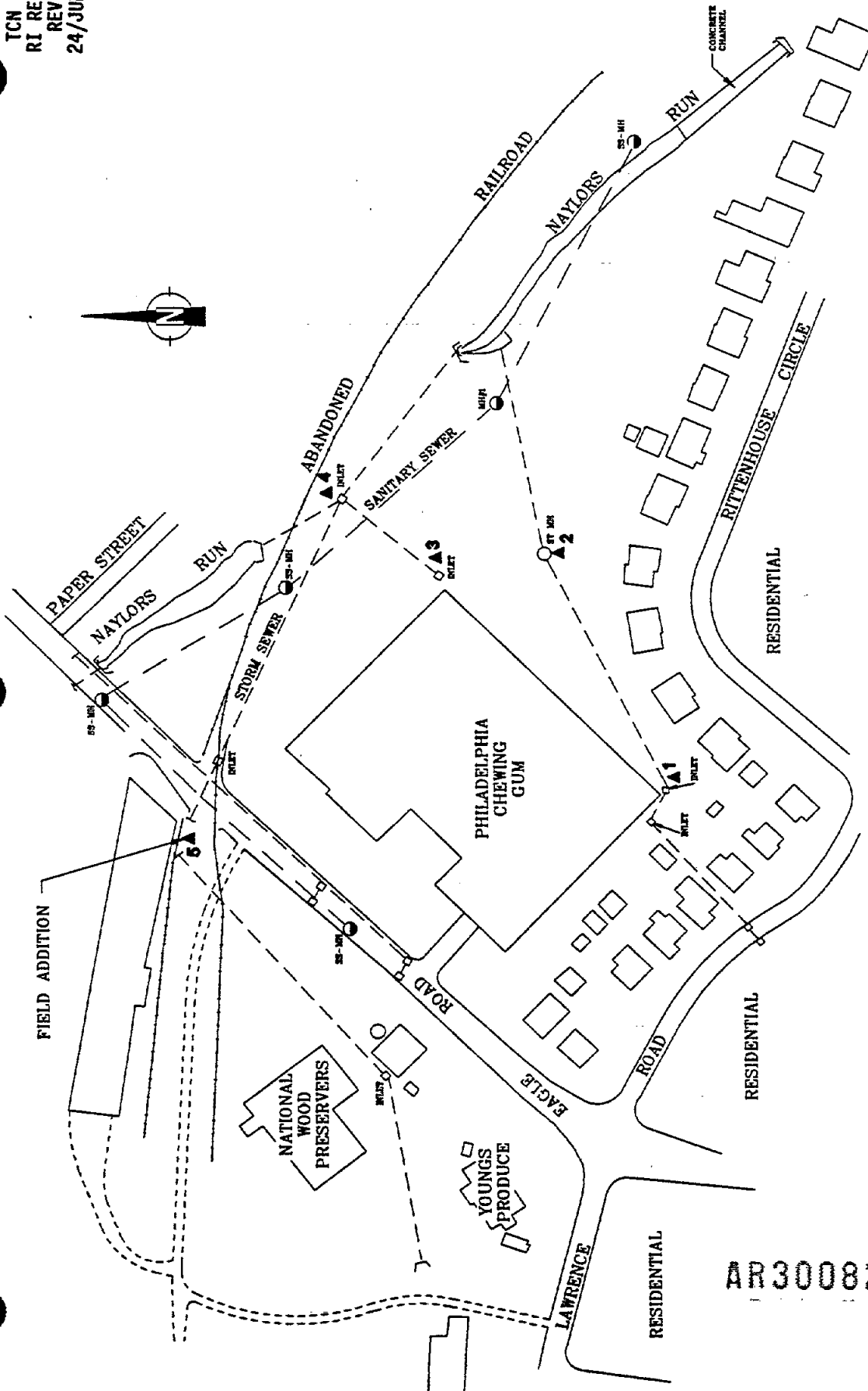
It was discovered during sampling that water was entering manhole #2 from two sources. A water discharge from Philadelphia Chewing Gum and upgradient storm water (from station 01) combine at the manhole designated station 02. Therefore two samples were collected at this manhole; sample "SS-AQ-02" was collected from the PCG discharge, and sample "SS-AQ-02A" was collected from the water traveling from manhole #1.

Methodology - Storm water samples were collected by having a field sampling team member, dressed in Level B protective equipment, enter the storm sewer, and with a decontaminated 32-ounce stainless-steel pitcher, fill the sample bottles. In order to collect sample "SS-AQ-02A", a temporary dam was constructed in the bottom of the manhole using visqueen. This was necessary because the rate of flow of water entering the manhole was very low. As the water slowly accumulated behind the dam, the water was collected in the stainless-steel pitcher. After all water samples were taken, the sediment samples were taken using a decontaminated stainless-steel scoop by the same field sampling team member. The stainless-steel scoop and pitcher were decontaminated between each sampling location.

3.3.2 Storm Sewer TV Inspection

Purpose and Scope- The purpose of inspecting the storm sewer was primarily to determine its integrity. The work was performed in April of 1991. It was suspected that the storm sewer running from Rittenhouse Circle, behind PCG, and emptying into the catch basin in Naylor's Run (Figure 3-4) was intercepting contaminated ground water and acting as a direct conduit for waste oil to enter the Run.

AR300826



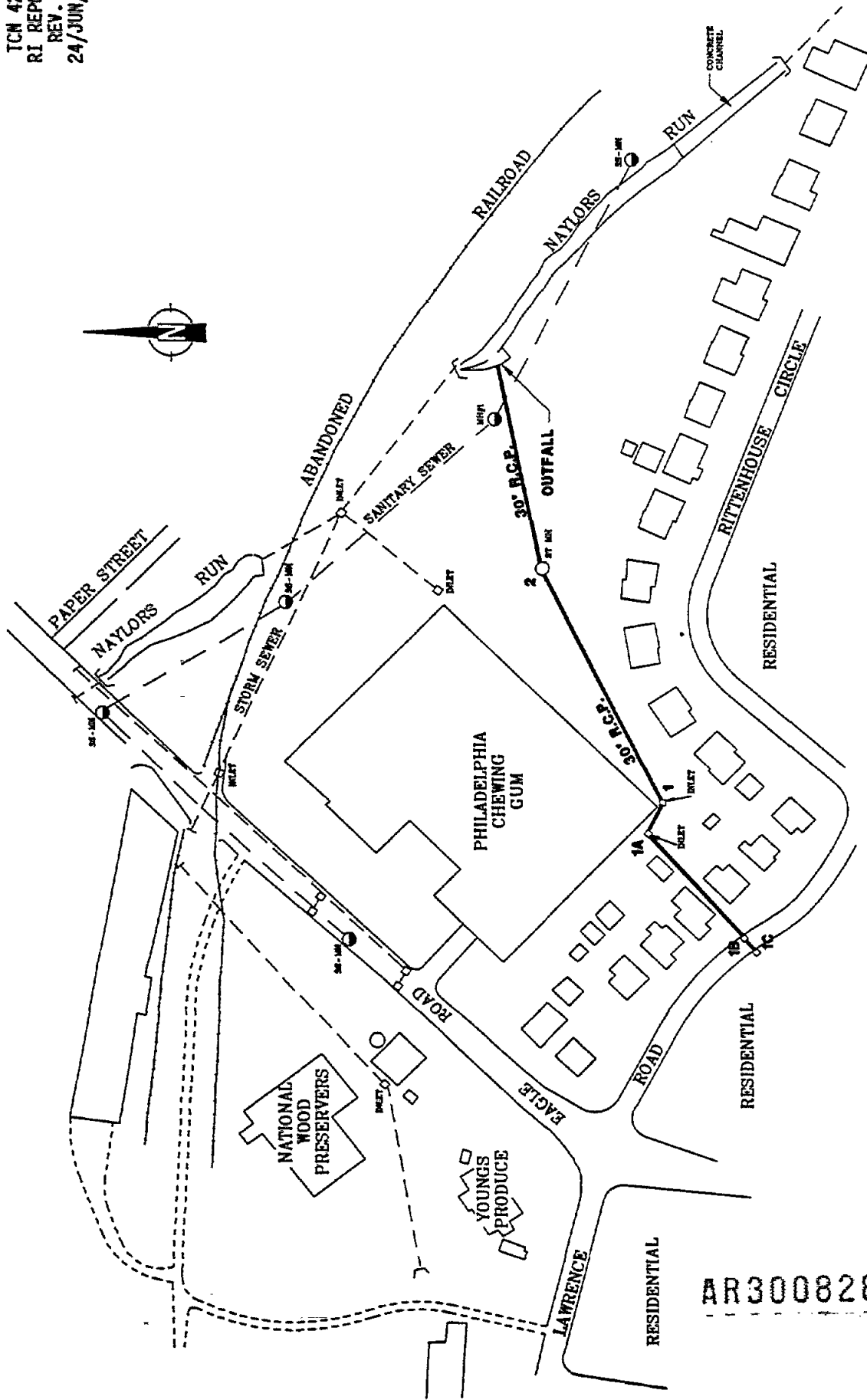
TETRA TECH, INC.



**FIGURE 3-3
HAVERTOWN PCP SITE
STORM SEWER SAMPLING
LOCATIONS**

- LEGEND:**
- ▲ SAMPLING POINTS FOR STORM SEWER (SEDIMENT & WATER)
 - SANITARY SEWER
 - STORM SEWER

AR300827



TETRA TECH, INC.

**FIGURE 3-4
HAVERTOWN PCP SITE
STORM SEWER TV
INSPECTION**

- LEGEND:**
- STORM SEWER TO BE TV INSPECTED
 - - - SANITARY SEWER
 - - - STORM SEWER



AR300828

Methodology- This work consisted of surveying the storm sewer with a video camera. The work was subcontracted to National Water Main Cleaning Company from Newark, New Jersey. The television camera used for the surveillance was specifically designed and constructed for such inspections. The camera was equipped with a light so that a clear picture of the entire periphery of the pipe was produced. Remote powered and controlled winches pulled the television camera, mounted on tank-like treads through the sewer line at a rate of less than 30 feet per minute. The camera was able to operate in 100 percent humidity conditions. The camera, television monitor and other components of the video system produced a minimum 500-line resolution video picture.

Measurements to locate defects and other points of interest were made according to the footage counter attached to the camera. Points marked include, but were not limited to, cracked or broken pipe, badly off-set joints and laterals with constantly running water or roots.

Documentation of surveillance included a written log and a standard 1/2" VHS video tape. The information included on the log and the tape include the location of the survey (site name and manhole numbers), date, pipe size and type, joint length, problem description, distance from station #, and location of nearby laterals.

3.4 ECOLOGICAL INVESTIGATION

Purpose and Scope - The objective of the ecological investigation was to determine the presence and evaluate the quality of the benthic community within Naylor's Run and at its confluence with Cobbs Creek, and to identify any observed terrestrial receptors associated with Naylor's Run. Cobbs Creek is classed as a warm water fish stream (PA Code, Title 25)

Four (4) ecological sample stations were selected from the eleven surface water and sediment sample locations associated with the investigation of Naylor's Run and Cobbs Creek (Figure 3-2). Stations were designated with the prefix "HV-EA" for Havertown Site-Ecological Assessment. Stations 08 and 10 correspond to the surface water and sediment sampling locations 08 and 10 along Naylor's Run.

Stations C01 and C02 (or COBB-01 and COBB-02) correspond to the surface water and sediment sampling locations 01 and 02 along Cobbs Creek.

Station 02 was initially selected to represent the area of greatest expected impact. Ideally, the area near station 04 would have been selected, however, the ecological sampling occurred during the installation of the oil/water separation facility. The stream disturbance caused by the installation activities resulted in station 04 being unsuitable for sampling. Station 02 was the next downstream location available. During previous site visits, it was determined that no continuous water flow occurred in Naylor's Run upstream of station 04. Upon mobilization of the field sampling crew to station 02, it was discovered that the oil/water separator installation activities had also impacted this area of Naylor's Run, therefore no samples of the flora or fauna were collected.

Station 08 was located approximately one half mile downstream from Station 02, in close proximity to surface water and sediment sampling station 01. Station 10 was located approximately two miles upstream from the confluence of Naylor's Run and Cobbs Creek.

Station C01 was located in Cobbs Creek approximately one hundred yards upstream from the confluence of Naylor's Run and Cobbs Creek. This location represented a section of Cobbs Creek that has not been influenced by Naylor's Run. Although Cobbs Creek is larger than Naylor's Run, the stream bed has characteristics similar to the unchanneled sections of Naylor's Run, thus making it desirable as a reference area.

Station C02 was located immediately downstream of the confluence of Naylor's Run and Cobbs Creek. When compared to station C01, data from this location aided in determining any environmental impacts within Cobbs Creek associated with Naylor's Run.

3.4.1 Aquatic Investigation

Methodology - Benthic macroinvertebrates were collected by a two-person Tetra Tech sampling team to gain qualitative information on the stream community.

Riffle/run and Coarse Particulate Organic Matter (CPOM) areas were sampled separately by Tetra Tech biologists.

The substrate in the riffle/run areas in the headwaters primarily consist of cobble. Sampling methodologies utilized D-Frame kick nets. Use of a D-Frame kick net gave flexibility in the benthic collection. Approximately one square meter of riffle/run substrate was sampled at each station (3-4 kick net collections). Effort was made to obtain representative organisms from all depths and riffle/run types.

The substrate in the CPOM areas within the headwaters primarily consist of detritus and bank vegetation. The methodologies used to sample the CPOM utilized the D-Frame kick net and hand grabs. Approximately one square meter of CPOM was sampled from each station. Effort was made to obtain representative organisms from all depths and CPOM types. In the downstream station there was little CPOM available to sample. Effort was required to obtain the requisite sample size.

Organisms were hand picked using forceps and pipets. All macroinvertebrate samples were placed into mason jars and kept on wet ice. All sample jars were labeled internally and externally. All hard-bodied organisms were preserved by being directly placed in 50% isopropanol. All soft-bodied organisms were heated in water to near boiling, and then placed into 50% isopropanol. The boiling kills digestive organisms within the gut of the collected macroinvertebrates, thus preventing internal digestion of the collected macroinvertebrate. Boiling also aids in distending the collected macroinvertebrate which facilitates the identification process. Detailed methodologies can be found in Appendix A.

All collected organisms were identified at the Tetra Tech facility. Occasionally incidental non-game fish and amphibians were obtained during the macroinvertebrate collection, which were identified to species level.

In addition to the macroinvertebrate collection, stream characterizations were performed at all sample stations. Characterization parameters included pH, Eh, conductivity, water temperature, stream depth, stream width, velocity, flow, high water mark, stream disturbances, riffle:run:pool percentages, surrounding land

use, canopy cover, sediment description, water description, dominant substrates, and observed relative abundances of the stream biota. The characterization results from each sampling station were compared to the reference station to determine morphological similarities and differences. The greater the similarity between the sample stations, the more meaningful the macroinvertebrate comparisons.

3.4.2 Terrestrial Investigation

Methodology - The terrestrial investigation focused on the identification of the terrestrial flora and fauna along the stream banks adjacent to the benthic sampling localities. An area of 100 square meters (10 meters by 10 meters) was observed on each bank at each locality. Plant species were identified to the species level, with dominant species noted. Particular attention was given to those plant species which contributed to the CPOM found in the stream bed.

In addition, all animal sightings, scat, tracks, and other related observations were recorded on field data sheets and/or in the field logbook. All terrestrial sampling localities were photo-documented.

AR300832

4.0 RESULTS OF INVESTIGATION

This section of the report presents the physical and chemical results of the field investigation portion of the Remedial Investigation. Results from this investigation are used to delineate the nature and extent of current contamination, and when compared with results from previous investigations, allow an assessment of temporal as well as spacial variations in contaminant occurrence.

4.1 DATA USE

A number of points need to be mentioned with regard to data use and presentation in this section. These points are given below.

- Two rounds of ground-water sampling were performed on the site. The first round of sampling was performed for screening purposes during August 20-30, 1990 to determine the need for additional downgradient wells. The furthest downgradient shallow well, HAV-07, previously had not shown the presence of pentachlorophenol (REWAI, 1988). The first round of data similarly showed that ground water containing PCP had not yet reached this well. It was therefore decided that additional downgradient wells in the shallow hydrologic zone were not necessary. It should be noted that the data was not validated after receipt from the CLP laboratories and hence is not discussed further.
- All analytes detected in any sample through laboratory analysis are included in the discussion. Some analytes may be qualified with the notations "J", "K", or "L". A "J" qualifier means the analyte was present, but the reported value may not be accurate or precise. A "K" qualifier means the analyte was present but the reported value may be biased high. A "L" qualifier means the analyte was present but the reported value may be biased low.
- The presence of all organic compounds are noted in the discussion, because the organic compounds tested for are not naturally occurring. However, because inorganic analytes may be present in the various media due to both

natural and anthropogenic sources, only the organic analytes that are found in concentrations that may pose a potential risk to human health or the environment will be discussed. These inorganic analytes will be referred to as "inorganic contaminants". The rationale for selecting specific inorganic contaminants will be given in Section 6.

- Quantitation limits are used to describe the lowest number that can be reported with accuracy and precision for organic compounds. Detection limits are used to describe the lowest concentration of an inorganic compound that can be measured with laboratory instruments. As mentioned previously, all samples collected in this investigation were submitted to laboratories that are part of the USEPA Contract Laboratory Program. Under the Contract Laboratory Program, there are contract required quantitation limits. However, the presence of any one analyte in a high concentration may raise the quantitation limit for all compounds in a given chemical class (for example, volatile organic compounds). When this occurs, the laboratory analyzing the sample may be allowed to exceed the contract required quantitation limits in some cases, as long as the analyte present in the highest concentration can accurately be quantified.
- Laboratory data used in this report have undergone several steps of review for accuracy. Once samples have been analyzed by a contract laboratory, the generated data is validated by Tetra Tech prior to its use in this report. Laboratory data that cannot be validated are not used. After Tetra Tech validates the laboratory data, the validation procedures are reviewed by USEPA prior to final acceptance of the data. This procedure is followed for all analyses except for dioxin analyses. For dioxin analyses, data validation is performed by another USEPA contractor. This contractor is a specialist in data validation and has received special training from the USEPA to perform this task. Once the dioxin data validation is complete, the validation is then reviewed by USEPA.
- There are numerous isomers of dioxin and the furans. Not all of the isomers are considered to pose a potential health risk. The isomer 2,3,7,8 TCDD is considered to pose the greatest potential risk to human health. Therefore,

the results of dioxin analysis have been summarized by calculating a toxicity equivalent (TE) of the isomer 2,3,7,8 TCDD for all dioxin isomers. An example of this calculation is found in Appendix B-5. The isomer 2,3,7,8-TCDD was actually detected in only one ground water sample (HAV-04). It was not found in any of the surface water or sediment samples.

4.2 HYDROGEOLOGICAL INVESTIGATION

4.2.1 Hydraulic Characteristics

Water Levels - As previously mentioned, this investigation consisted of measurement of ground-water levels and free product thickness over a seven month period and two rounds of ground-water sampling from 28 monitoring wells.

Water level data for the 28 wells are presented in Table 4-1. During the seven month period over which water levels of PCP were measured, three slightly different trends were noted with regard to water level elevation (Figure 4-1). Monitoring wells located the furthest distance from Naylor's Run with the highest water level elevation (approximately 300 feet above mean sea level) showed a slight decrease in water levels. Examples of this decrease are observed in wells R-4 and CW-4S. Monitoring wells located closer to Naylor's Run with intermediate water level elevations, such as well HAV-04, with an average water level elevation of 291 feet, show little change in water level. Wells located closest to Naylor's Run, such as CW-6S, HAV-08, and HAV-07, show a trend of increasing water level elevation over the period of measurement.

These trends in water level, in a general sense, may reflect seasonal changes in ground-water levels related to recharge and depth to the water table from land surface. Rainfall data collected during the same period at the Philadelphia International Airport show low total precipitation from August through November of 1990, as compared to the period December, 1990 through March, 1991 (Figure 4-2). However, these trends are probably not of significance because the maximum change in water level is only 1 foot.

AR300835

**TABLE 4-1
HAVERTOWN PCP SITE
WATER LEVEL ELEVATIONS**

TCN 4212
PI REPORT
REV. #1
/JUN/91

MONITORING WELL	PVC CASING ELEVATION	DEPTH TO WATER	WATER ELEVATION	DEPTH TO WATER	WATER ELEVATION
		August 2, 1990		September 21, 1990	
CW-1D	308.80	8.05	300.75	8.15	300.65
CW-1I	308.82	9.09	299.73	9.12	299.70
CW-1S	309.39	9.33	300.06	9.42	299.97
CW-2D	307.81	12.78	295.03	12.81	295.00
CW-2I	307.59	12.53	295.06	12.62	294.97
CW-2S	307.35	12.26	295.09	12.33	295.02
CW-3D	305.13	10.05	295.08	10.96	294.17
CW-3I	305.06	10.88	294.18	NO ACCESS	
CW-3S	304.99	10.90	294.09	11.25	293.74
CW-4D	305.66	10.27	295.39	10.29	295.37
CW-4I	305.77	10.60	295.17	10.71	295.06
CW-4S	305.90	11.34	294.56	11.50	294.40
CW-5D	304.65	7.69	296.96	7.68	296.97
CW-5I	304.43	7.96	296.47	7.93	296.50
CW-5S	304.61	8.40	296.21	8.28	296.33
CW-6D	301.34	13.66	287.68	14.17	287.17
CW-6I	301.20	13.88	287.32	14.83	286.37
CW-6S	301.10	15.09	286.01	15.03	286.07
HAV-02	307.00	PRODUCT	0.02*	PRODUCT	0.02*
HAV-04	294.65	3.30	291.35	3.32	291.33
HAV-05	294.66	2.68	291.98	2.58	292.08
HAV-07	283.84	2.59	281.25	2.52	281.32
HAV-08	286.75	3.30	283.45	4.53	282.22
R-2	314.24	PRODUCT	0.68*	PRODUCT	0.55*
R-4	315.50	17.35	298.25	17.43	298.17
NW-1	307.48	11.90	295.58	11.98	295.50
NW-2	306.45	NOT FOUND	-----	NOT FOUND	-----
NW-3	307.63	7.97	299.64	7.99	299.62
NW-6	306.41	7.59	298.83	7.61	298.81

* PRODUCT THICKNESS (feet)

AR300836

**TABLE 4-1
HAVERTOWN PCP SITE
WATER LEVEL ELEVATIONS
(Continued)**

TCN 4212
RI REPORT
REV. #1
24/JUN/91

MONITORING WELL	PVC CASING ELEVATION	DEPTH TO WATER	WATER ELEVATION	DEPTH TO WATER	WATER ELEVATION
		October 25, 1990		December 18, 1990	
CW-1D	308.80	9.77	299.03	9.33	299.47
CW-1I	308.82	9.80	299.02	9.40	299.42
CW-1S	309.39	10.02	299.37	9.63	299.76
CW-2D	307.81	13.40	294.41	12.80	295.01
CW-2I	307.59	13.11	294.48	12.43	295.16
CW-2S	307.35	13.01	294.34	12.32	295.03
CW-3D	305.13	11.59	293.54	11.13	294.00
CW-3I	305.06	NO ACCESS	-----	NO ACCESS	-----
CW-3S	304.99	11.71	293.28	11.10	293.89
CW-4D	305.66	11.61	294.05	11.25	294.41
CW-4I	305.77	11.95	293.82	11.43	294.34
CW-4S	305.90	12.32	293.58	12.15	293.75
CW-5D	304.65	9.06	295.59	8.77	295.88
CW-5I	304.43	9.30	295.13	9.25	295.18
CW-5S	304.61	9.64	294.97	9.33	295.28
CW-6D	301.34	14.84	286.50	14.25	287.09
CW-6I	301.20	15.15	286.05	14.90	286.30
CW-6S	301.10	15.21	285.89	15.00	286.10
HAV-02	307.00	PRODUCT	0.01*	PRODUCT	0.02*
HAV-04	294.65	3.64	291.01	3.14	291.51
HAV-05	294.66	3.09	291.57	2.87	291.79
HAV-07	283.84	2.30	281.54	1.79	282.05
HAV-08	286.75	4.46	282.29	4.23	282.52
R-2	314.24	PRODUCT	1.77*	PRODUCT	0.55*
R-4	315.60	19.15	296.45	18.87	296.73
NW-1	307.48	12.39	295.09	12.11	295.37
NW-2	306.45	NOT FOUND	-----	NOT FOUND	-----
NW-3	307.61	8.44	299.17	8.00	299.61
NW-6	306.42	9.01	297.41	8.45	297.97
EPA-01		PRODUCT	0.05*	PRODUCT	0.06*
**NAYLORS	284.65	4.70	279.95	NO DATA	00837 -----

* PRODUCT THICKNESS (feet)

** MEASURED AT OUTSIDE CORNER OF CATCH BASIN

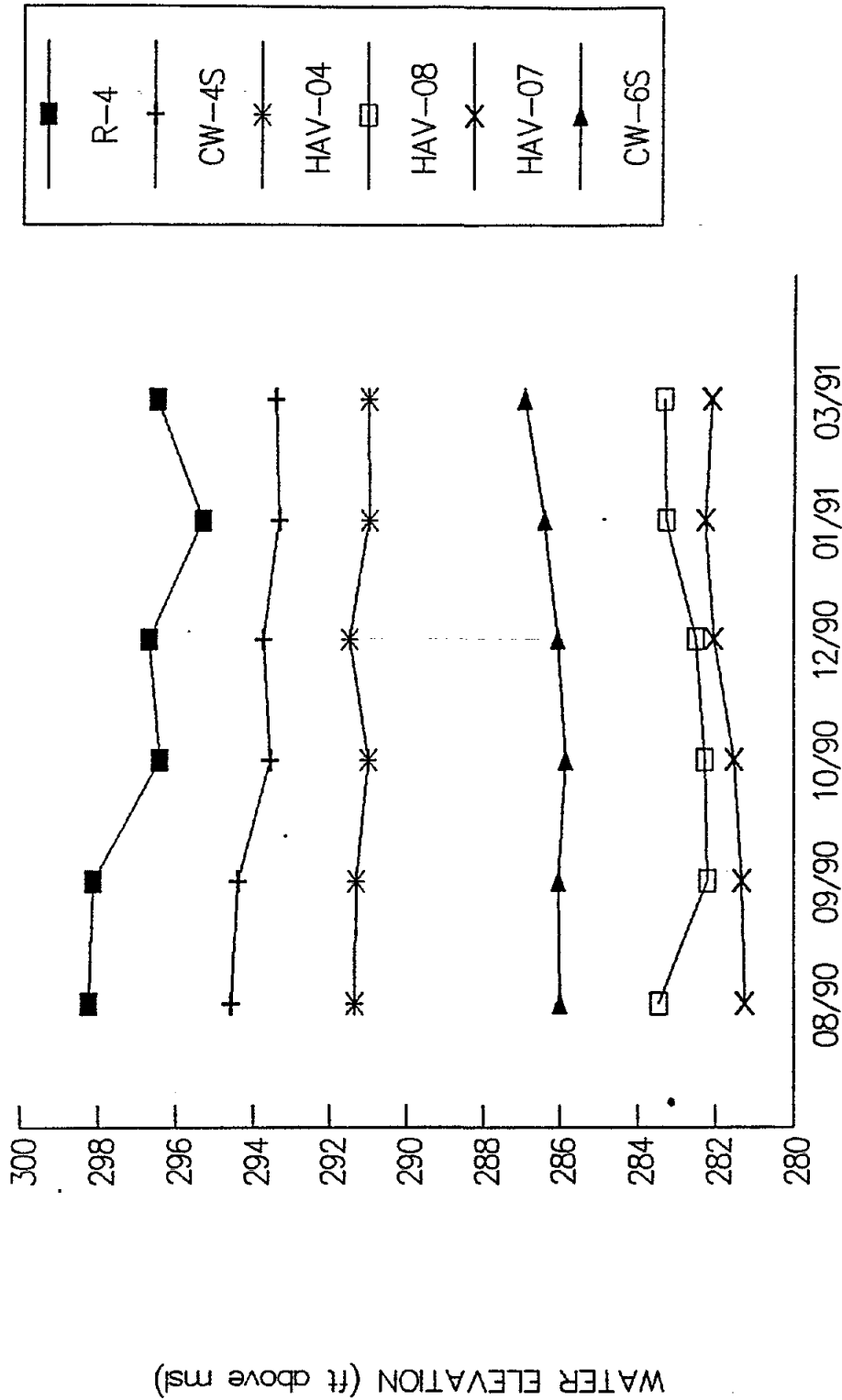
**TABLE 4-1
HAVERTOWN PCP SITE
WATER LEVEL ELEVATIONS
(Continued)**

TCN 4212
RI REPORT
REV. #1
24/JUN/91

MONITORING WELL	PVC CASING ELEVATION	DEPTH TO WATER	WATER ELEVATION	DEPTH TO WATER	WATER ELEVATION
		January 17, 1991		March 7, 1991	
CW-1D	308.80	9.29	299.51	9.20	299.60
CW-1I	308.82	9.31	299.51	9.24	299.58
CW-1S	309.39	9.48	299.91	9.41	299.98
CW-2D	307.81	13.13	294.68	13.08	294.73
CW-2I	307.59	12.77	294.82	12.70	294.89
CW-2S	307.95	13.44	293.91	13.33	294.02
CW-3D	305.13	11.33	293.80	11.19	293.94
CW-3I	305.06	NO ACCESS	-----	NO ACCESS	-----
CW-3S	304.99	11.25	293.74	11.11	293.88
CW-4D	305.66	12.10	293.56	11.83	293.83
CW-4I	305.77	12.43	293.34	12.20	293.57
CW-4S	305.90	12.52	293.38	12.43	293.47
CW-5D	304.65	9.65	295.00	9.57	295.08
CW-5I	304.43	9.82	294.61	9.78	294.65
CW-5S	304.61	10.18	294.43	10.06	294.55
CW-6D	301.84	14.56	286.78	14.01	287.33
CW-6I	301.20	14.76	286.44	14.21	286.99
CW-6S	301.10	14.63	286.47	14.13	286.97
HAV-02	307.00	PRODUCT	0.21*	PRODUCT	0.19*
HAV-04	294.65	3.64	291.01	3.59	291.06
HAV-05	294.66	3.20	291.46	3.10	291.56
HAV-07	283.84	1.55	282.29	1.70	282.14
HAV-08	286.75	3.44	283.31	3.39	283.36
R-2	314.24	PRODUCT	2.78*	PRODUCT	2.83*
R-4	315.60	20.26	295.34	20.19	295.41
NW-1	307.48	11.95	295.53	11.88	295.60
NW-2	306.45	NOT FOUND	-----	NO DATA	-----
NW-3	307.61	7.62	299.99	7.54	300.07
NW-6	306.42	9.93	296.49	9.86	296.56
EPA-01		PRODUCT	0.09*	PRODUCT	0.11*
**NAYLORS	284.65	4.75	279.90	APR 30 0838 DRY	

* PRODUCT THICKNESS (feet)

** MEASURED AT OUTSIDE CORNER OF CATCH BASIN

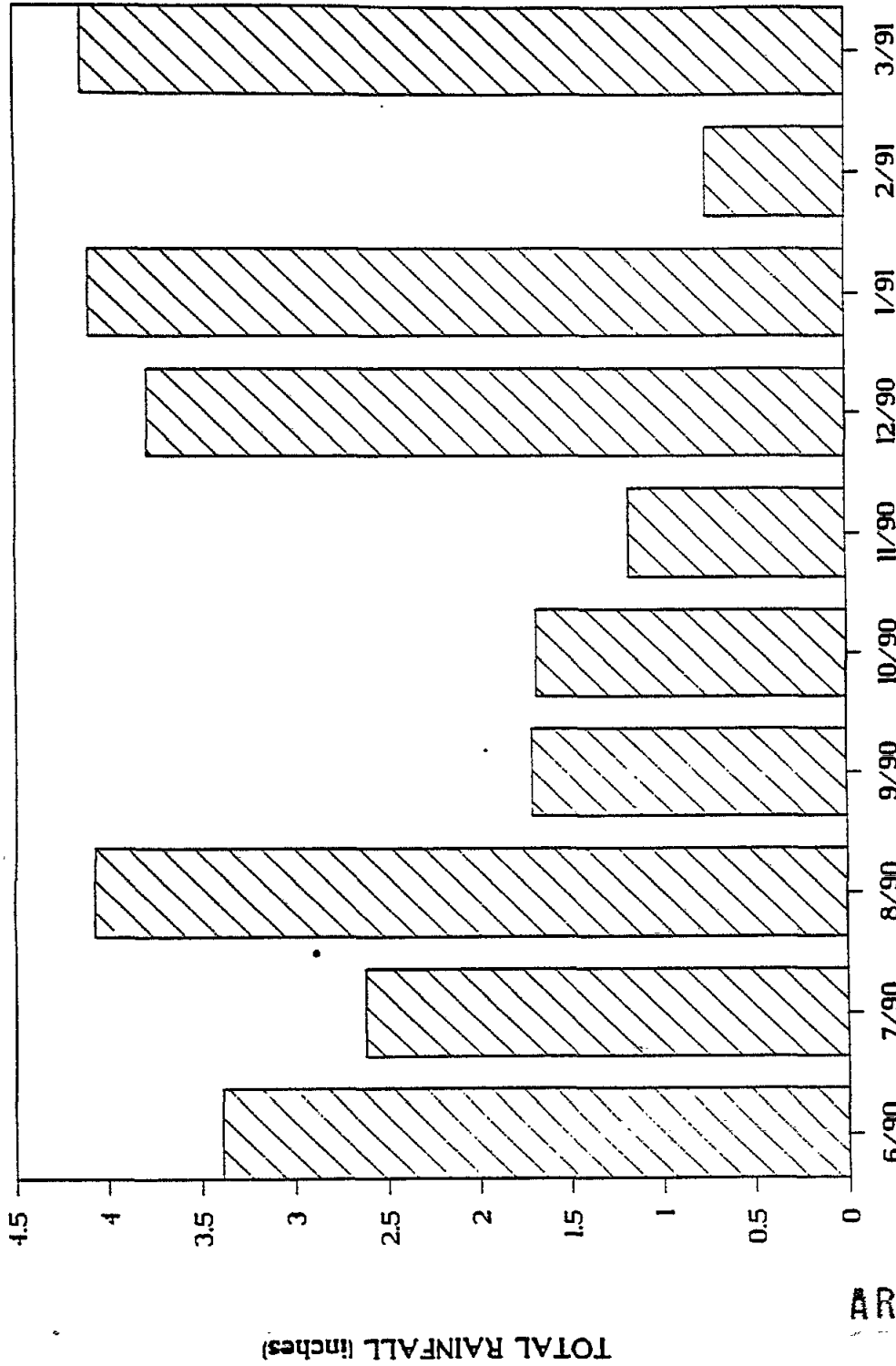


AR300839

TETRA TECH, INC.



FIGURE 4-1
HAVERTOWN PCP SITE
WATER LEVEL CHANGE
IN 6 SELECTED WELLS



AR300840



TETRA TECH, INC.

FIGURE 4-2
TOTAL RAINFALL
PHILADELPHIA AIRPORT

Horizontal Gradient - The water level information is better used to calculate horizontal and vertical flow gradient and direction. Water level elevations for the shallow and deep hydrologic zones have been plotted in Figures 4-3 and 4-4, respectively. The horizontal flow direction is clearly from west to east, toward Naylor's Run in both the shallow and the deep hydrologic zone.

The integrated horizontal hydraulic gradient in the shallow hydrologic zone, from well CW-1S to HAV-07 is 0.017. However, the gradient is relatively small in the vicinity of NWP and increases to the east of PCG. R. E. Wright Associates (1988) suggested this is due to a change in the permeability in the subsurface materials. Naylor's Run was previously located to the south of its present position and a potential change in subsurface permeability may be associated with buried stream channel deposits. Alternatively, the change in gradient may simply be related to the change in surface topography east of PCG.

Horizontal Flow Velocity - A horizontal linear flow velocity in the shallow hydrologic zone was calculated using Darcy's Law. Using a hydraulic gradient of 0.017, and values determined in R.E. Wright's 1988 investigation for porosity (21 percent) and hydraulic conductivity (2.94 ft/day), the average linear velocity of 0.22 ft/day was calculated.

Vertical Gradient - The ground-water level data were also used to calculate vertical flow gradients and direction in the 6 cluster wells for the 6 periods of measurement (Table 4-2). Cluster well group 1, located on NWP, shows downward flow from October, 1990 through March, 1991. Cluster well group 2 shows a fluctuation in vertical flow direction over the period of study. Both of these cluster well groups are located on NWP property. Cluster well groups 3 through 6 all show consistently upward flow. These cluster wells are located on the four corners of the PCG building (see Figure 3-1).

Ground Water Discharge to Naylor's Run - The ground water level data indicate that the shallow hydrologic zone is providing some base flow to Naylor's Run in the reach southeast of the catch basin. Additionally, vertical gradient data indicate that the deep hydrologic zone is providing (some) upward recharge to the shallow hydrologic zone in this area. It is probable however, that some water



TABLE 4-2
HAVERTOWN PCP SITE
VERTICAL GRADIENTS AND DIRECTION OF FLOW

WELLS	AUGUST 90		SEPTEMBER 90		OCTOBER 90		DECEMBER 90		JANUARY 91		MARCH 91	
	Vert. Grad.	Direction	Vert. Grad.	Direction	Vert. Grad.	Direction	Vert. Grad.	Direction	Vert. Grad.	Direction	Vert. Grad.	Direction
CW-1S/ CW-1D	-0.02	Upward	-0.02	Upward	0.01	Downward	0.009	Downward	0.012	Downward	0.011	Downward
CW-2S/ CW-2D	0.0015	Downward	0.0005	Downward	-0.002	Upward	0.0005	Downward	-0.019	Upward	-0.018	Upward
CW-3S/ CW-3D	-0.035	Upward	-0.015	Upward	-0.009	Upward	-0.024	Upward	-0.002	Upward	-0.002	Upward
CW-4S/ CW-4D	-0.028	Upward	-0.032	Upward	-0.016	Upward	-0.022	Upward	-0.006	Upward	-0.012	Upward
CW-5S/ CW-5D	-0.028	Upward	-0.023	Upward	-0.022	Upward	-0.021	Upward	-0.020	Upward	-0.019	Upward
CW-6S/ CW-6D	-0.064	Upward	-0.042	Upward	-0.024	Upward	-0.038	Upward	-0.012	Upward	-0.014	Upward

AR300842

in the deeper hydrologic zone is travelling beneath Naylor's Run and discharging at some other point(s). Other discharge points were not determined as part of this investigation.

The ground water is apparently not providing any base flow to the reach of Naylor's Run located immediately southeast of Eagle Road. This portion of Naylor's Run was observed to carry water only during storm events.

4.2.2 Results of Chemical Sampling

The second round of ground water sampling was performed during the period November 7-15, 1990. The results of this sampling event are presented below, and indicate that most of monitoring wells show the presence of some contaminants, with pentachlorophenol (PCP) present in nearly every monitoring well. The complete data set for this round of sampling is found in Appendix B.

Volatile Organic Compounds - As a group, volatile organic compounds (VOCs) are very prevalent in the ground water with benzene, total xylenes, trichloroethene, 1,2-dichloroethene, and vinyl chloride representing the dominant VOCs observed (Figure 4-5). Presently, trichloroethene and 1,2-dichloroethene are found in highest concentrations in cluster well group 1, located on the NWP property (maximum concentration of 630 and 270 ug/l, respectively). Trichloroethene and 1,2 dichloroethene decrease from west to east across the site extending to both the furthest downgradient shallow well (HAV-07) and the furthest downgradient deep well (CW-6D). On the other hand, benzene and total xylenes are found in lower concentrations, 1 and 110 ug/l, respectively, on NWP property relative to concentrations of up to 270 and 1700 ug/l, respectively, on the southwest and southeast sides of the PCG building. Benzene and total xylenes are present in deep well CW-6D but not in shallow well HAV-07.

The results of sampling performed in March, 1988 (REWAI, 1988) show much the same distribution pattern of VOCs in the ground water (Figure 4-6) as they did in November, 1990. However, the VOC concentration in the ground water has generally decreased between 1988 and 1990. Decreases in trichloroethene and 1,2-dichloroethene were noted in wells CW-11 and CW-1D. (An increase was observed

in CW-1S). The VOCs in the ground water have also diminished in concentration in cluster well group 3 and cluster well group 5. In cluster well group 4, benzene and total xylenes have increased since 1988 but TCE and 1,2-dichloroethene have decreased since 1988. A reduction in VOC concentration is also observed in cluster well group 2 and well NW-1-81, although the samples collected in 1990 had higher quantitation limits than those obtained in 1988, and thus do not allow confirmation. An apparent decrease in VOCs is also observed in well R-2 between 1988 and 1990. However, again, high quantitation limits for the sample collected in 1990 (1000 and 2000 ug/l) distort the picture. There has been little change in VOC concentration in cluster well group 6 from 1988 to 1990.

Semi-Volatile Organic Compounds - As mentioned above, PCP which is known to originate from the NWP property, is found in nearly every monitoring well on the HAVER TOWN site (Figure 4-7). Moreover, it represents the largest percentage of total semi-volatile organic compounds detected in the ground water. The combination of PCP and polycyclic aromatic hydrocarbons (PAHs), a subgroup of semi-volatile organic compounds, account for nearly all of semi-volatile organic compounds present in the ground water. Highest levels were observed in the shallow hydrologic zone in wells R-2 (which contains free product) and HAV-04 at concentrations of 80,000 and 63,000 ug/l, respectively. Well HAV-02, which is located immediately downgradient of R-2, showed a trace of floating product, yet contained only 1,900 ug/l of PCP.

In comparing the PCP concentration between the shallow and the deep hydrologic zones, PCP concentrations are higher in the shallow hydrologic zone on NWP (in cluster well groups 1 and 2) but are lower in the shallow hydrologic zone on Philadelphia Chewing Gum property (in cluster well group 3, 5, and 6). The PCP concentration is nearly equal in the shallow and the deep hydrologic zones in cluster well group 4.

An important point to note is that PCP was observed in the November 1990 sampling event for the first time in the furthest downgradient shallow well HAV-07 in a concentration of 14 ug/l, although this value is flagged with a "1" qualifier.

AR300844

An interesting note is that the concentration of PCP decreases more than an order of magnitude between HAV-04 and HAV-05. These two wells are less than 50 feet apart, are of similar depth (6 and 11.5 feet below grade, respectively), are presumably screened in similar geologic materials (no borings logs are available), yet are located on either side of the storm sewer line running behind the PCG building. This may indicate that the storm sewer is intercepting some ground water.

In comparing the results of the 1988 sampling performed by R.E. Wright Associates (1988) to the 1990 data, a clear increase in the concentration of PCP is observed for most of the monitoring wells (Figure 4-8). An increase in PCP concentration is observed in all wells except cluster well group 3, cluster well group 5, well NW-1-81, and well NW-3-81. This pattern may be associated with the thickness of free oil product measured in the wells.

In 1988, (REWAI, 1988) over 4 feet and almost 1 foot of free product were reported in wells R-2 and HAV-02, respectively. In June, 1989 R. E. Wright Associates performed a free product pilot recovery test. Fifty-six gallons of free product were removed from well R-2 and 0.16 gallons were removed from well HAV-02 in the first two weeks of the test. No further oil was recovered in the remainder of a two month test. In early August, 1990, free product thickness in well R-2 was 0.68 feet and was 0.02 feet in HAV-02 (Table 4-1). This thickness of product apparently represents the free product that has re-accumulated in the wells since June, 1989.

Free product was again removed from these wells each of the two times the wells were sampled in 1990 (August 20-30 and November 7-15). In well R-2, free product thickness increased after both sampling events, compared to its presampling level; up to 1.77 feet after the August, 1990 sampling event, and up to 2.78 feet after the November, 1990 sampling event. Free product thickness did not increase in HAV-02 after the August sampling event, but did increase to 0.21 feet after the November sampling event.

Although the thickness of free product has certainly been affected by several purging events between 1988 and 1990, the amount of free product has been stable

from January to March 1991 (~2.8 feet in R-2 and ~0.20 feet in HAV-02) and may represent the maximum level of recovery. Thus overall, there has been a decrease in free product thickness from 1988 to present. The increase in PCP concentration observed between 1988 and 1990 would seem to be related to the decrease in free product thickness. It would seem likely that some free product has dissolved in the water resulting in increased PCP concentrations.

Pesticides and PCB's - The pesticide Endosulfan II was detected in well R-2 in a concentration of 3.5 ug/l and dieldrin was detected in well R-4 in a concentration of 0.61 ug/l.

Inorganic Contaminants - Several inorganic contaminants were present in the ground water. They were aluminum, arsenic, cobalt, and manganese. Aluminum was present in 12 wells in concentrations ranging from 31.4 ug/l at well CW-4D to 2390 ug/l at well CW-2D. Arsenic was found in 11 wells in concentrations ranging between 2 and 28 ug/l. Cobalt was present in 26 of the 28 wells at concentrations ranging from 6.4 to 413 ug/l. Manganese was present in all 28 wells in concentrations ranging from 28.5 to 22,600 ug/l.

Dioxin- As mentioned previously, the results of dioxin analysis have been summarized by calculating a toxicity equivalent (TE) of the isomer 2,3,7,8 TCDD for all dioxin isomers. Dioxin isomers were found in many of the water samples. Notably, high values of 2,3,7,8 TCDD TE ranging from 3.599 to 173.739 parts per trillion (ppt) were found in wells HAV-05, NW-1-81, HAV-04, HAV-02, and R-2 (Figure 4-9). Wells HAV-04, HAV-02, and R-2 have contained in the past, or still presently contain free product. It also should be noted that the furthest downgradient shallow well HAV-07 has a 2,3,7,8 TCDD TE of 0.212 parts per trillion.

In 1988, R.E. Wright Associates (1988) also sampled for dioxin and its isomers in the ground water. Tetra Tech has calculated a 2,3,7,8 TCDD TE using their raw data. The 1990 results are dramatically higher than those obtained in 1988. Only well NW-1-81 exhibited dioxin concentrations in 1988 (Figure 4-10) similar to those exhibited in November, 1990.

AR300846

Summary - Volatile organic and semi-volatile organic compounds are found throughout the ground water at the HAVERTOWN site. The concentration of volatile organic compounds has apparently decreased in many of the well locations on the site. Semi-volatile organic compounds have generally increased in concentration since 1988. This may be related to a decrease in the thickness of free product observed in the shallow hydrologic zone, suggesting dissolution of the free product into the ground water. Dioxin concentrations have apparently increased dramatically since 1988, especially in wells that still contain free floating product.

4.3 INVESTIGATION OF NAYLORS RUN AND COBBS CREEK

4.3.1 Field Parameters

During the two field sampling events in Naylor's Run and Cobbs Creek, a number of physical parameters were measured, including temperature, pH, specific conductance, and Eh (Table 4-3).

The average temperature measured in Naylor's Run stations 01 through 06 in the September sampling event was 16.7°C. This temperature reflects the air temperature due to the shallowness of the Run at these stations. The average temperature measured in the January, 1991 sampling event was 6°C, again reflecting surface air temperatures for that time of year.

The pH measured at all stations ranged from a low of 6.5 to a high of 8.6 units and represents a generally neutral pH.

The specific conductance of the water ranged from 69 to 219 $\mu\text{S}/\text{cm}$ in stations 01 through 06 in the reach of Naylor's Run closest to the catch basin and from 209 to 309 measured in the lower reach of Naylor's Run and upper reach of Cobbs Creek.

The Eh of the water at Naylor's Run stations 08 through 10 and Cobbs Creek stations 01 and 02 ranged from +2 to +110 mv, indicating a transition environment between environments isolated from the atmosphere and environments

TABLE 4-3
HAVERTOWN PCP SITE
SURFACE WATER AND SEDIMENT SAMPLING
NAYLORS RUN AND COBBS CREEK

DATE	LOCATION	STATION	(units) pH	(°C) Temp.	(u/cm) SPECIFIC CONDUCTIVITY	(mV) Eh
9/19/90	Naylors	1	7.7	15.5	69	-
9/19/90	Naylors	2	6.6	16.7	184	-
9/19/90	Naylors	3	7.0	17.8	219	-
9/19/90	Naylors	4	6.9	17.8	216	-
9/19/90	Naylors	5	-	seep only	-	-
9/19/90	Naylors	6	6.8	15.5	136	-
1/30/91	Naylors	8	7.34	7.8	209	027
1/30/91	Naylors	9	7.62	6.9	214	053
1/30/91	Naylors	10	7.65	5.3	304	040
1/30/91	Cobbs	1	8.60	5.4	309	110
1/30/91	Cobbs	2	7.83	4.4	228	002

AR300848

in contact with the atmosphere. This may be additional evidence that much of the flow in these streams is provided from ground water recharge.

Grain size analyses were performed at 9 of the surface water and sediment sampling locations. The sediments in Naylor's Run and Cobbs Creek are largely dominated by sand-sized sediments with a range of 58 % sand to 99.9 % sand (Table 4-4). The median grain size of the sediment from the 9 stations is 1.5 mm and would be classed a coarse sand (Wentworth, 1922). It should be noted that all grain size analysis was intended to be supplemental to the chemical analysis. This being the case, all samples were specifically collected in areas of non-turbulent flow where deposition would normally predominate over erosion. Therefore, the grain size analyses are not necessarily representative of the grain size of all sediments in the stream and may underestimate mean grain size. The complete grain size analyses are presented in Appendix C.

4.3.2 Results of Chemical Sampling

In September, 1990, five surface water and six sediment samples were collected from Naylor's Run. These samples were analyzed for TCL organic compounds and TAL inorganic compounds. In January, 1991, an additional five surface water and five sediment samples were collected from downstream locations in Naylor's Run and Cobbs Creek. These samples were analyzed for TCL semi-volatile organic compounds only. All data for these sampling events can be found in Appendix D.

Volatile Organic Compounds - Volatile organic compounds are found predominantly in the surface water, rather than in the sediments in Naylor's Run (Figure 4-11). More specifically, VOCs are only found in the reach of Naylor's Run downstream of the catch basin. As in the ground water samples, the compounds most often found in the surface water samples were benzene, toluene, ethylbenzene, xylenes, and trichloroethene. Concentrations exhibited a predictable downstream decrease in concentration from 31 to 10 ug/l for benzene; 33 to 6 ug/l for ethylbenzene; 160 to 44 ug/l for total xylenes; and from 7 to 2 ug/l for trichloroethene. Total VOC concentration was 234 ug/l at station NAY-AQ-03, collected inside the catch basin; 205 ug/l at station NAY-AQ-04, collected immediately outside the catch

AR300849

TABLE 4-4
HAVERTOWN PCP SITE
GRAIN SIZE DATA

	% GRAVEL AND SAND	% SILT AND % CLAY	D ₅₀ (mm)
NAY-01	98.5	1.5	3.6
NAY-02	97.5	2.5	2.7
NAY-04	97.4	2.6	1.9
NAY-06	96.4	3.6	1.8
NAY-08	98.8	1.2	0.68
NAY-09	97.8	2.2	0.68
NAY-10	97.7	2.3	0.41
COBB-01	99.8	0.2	1.03
COBB-02	99.9	- -	0.74

D₅₀ - median grain size

AR300850

basin; and 63 ug/l at station NAY-AQ-02. No VOCs were found in either the sediment or the surface water at the furthest downstream station (NAY-01).

There appears to be little difference in the distribution or concentration of VOCs in surface water samples collected in 1988 (REWAI, 1988; Figure 4-12) as compared to those from 1990. One minor difference is that some VOCs were detected in the reach of Naylor's Run above the catch basin in 1988.

Semi-Volatile Organic Compounds - PCP was present in sediment samples at stations 01, 02, 04, 06, and 08 in concentrations ranging from 3000 (J) ug/kg at station 06 decreasing downstream to 360 (J) ug/kg at Station 08 (Figure 4-13). PCP may also be present in the sediment at stations 03 and 05, but this cannot be confirmed because of high quantitation limits for these samples. Downstream of station 08, no PCP was found in the sediments above quantitation limits. The contribution of PCP to the concentration of total semi-volatile organic compounds is generally small at the stations where PCP is present. On the other hand, the PAHs make up the majority of the semi-volatile organic compounds in the sediment at all stations sampled.

In contrast to the relatively small contribution of PCP to the total concentration of semi-volatile organic compounds present in the sediment, PCP makes up almost all of the total semi-volatile organic compounds present in the surface water. The dominance of the semi-volatile organic compounds by PCP in the surface water is similar to the condition found in the ground water. The concentration of PCP in the water was 1200 ug/l in the catch basin, 380 ug/l immediately outside the catch basin (station 04), 525 ug/l at station 02 (averaged with duplicate sample), and 21 ug/l at station 01.

Concentrations of PCP in the surface water continued to decrease from station 08 (140 ug/l) downstream to Cobbs Creek station 01 (3 J ug/l). It should be noted that the concentration of PCP in the water at station 08 was higher than at station 01 even though station 01 is located upstream of station 08. This may simply reflect that the samples at stations 01 through 06 were collected in September 1990 and samples at Naylor's Run stations 08 through 10 and Cobbs Creek

AR300851

stations 01 and 02 were collected in January, 1991. The important point is that PCP concentrations show a downstream decrease in concentration.

PCP was also present in the surface water in the reach of Naylor's Run above the catch basin (18 (J) ug/l at station 06). This was the only station above the catch basin where enough water was present for collection.

The data collected in 1988 (REWAI, 1988) showed a situation similar to the present results, in which PCP was the primary and almost exclusive semi-volatile organic compound present in the surface water. As in the results of this investigation, PCP was present in the surface water below the catch basin but is absent from the surface water upstream of the catch basin (Figure 4-14). These results would seem to indicate that ground water, providing base flow to Naylor's Run below the catch basin, is the major contributor to the presence of PCP in the surface water of Naylor's Run.

Although a direct comparison is difficult because the locations of the sampling stations in this investigation were slightly different than those in 1988, it does not appear that the concentration of PCP in the surface water has changed significantly over the last two years (Figure 4-15).

There also does not appear to be a significant difference in the concentration of PCP in the sediment between 1988 and 1990, although comparison is even more difficult because most of the reported PCP concentrations in this study have been qualified (with a J) as being inaccurate or imprecise. One major difference from the 1988 data is that no PCP was present in the sediment in the reach of Naylor's Run above the catch basin in 1988 but there was 3000 (J) ug/kg of PCP in the sediment at station 06 in 1990.

In both 1988 and 1990, PCP is generally found in higher concentrations in the sediment than in the surface water at the same location (again bearing in mind "J" qualifiers on the 1990 sediment data). This probably reflects the relatively low solubility of PCP in water. The solubility of PCP in water will be discussed further in Section 5.

AR300852

Pesticides and PCBs - The pesticides gamma-BHC, 4,4'-DDD, heptachlor epoxide, and dieldrin were found in the surface water in maximum concentrations of 0.054 ug/l, 0.38 ug/l, 0.77 ug/l, and 0.34 ug/l, respectively. At least one pesticide was found at every surface water station, but no more than two pesticides were present at any one station.

Pesticides were more abundant in the sediment samples. Dieldrin, beta-BHC, heptachlor, aldrin, 4,4'-DDD, endosulfan sulfate, and endrin were all found in at least one sediment sample. The maximum concentration of all pesticides present was heptachlor at station 03 in a concentration of 160 ug/kg. Only station 05, which was soil collected from a seep and was not a true sediment sample, contained no pesticides.

Inorganic Contaminants - Aluminum, cobalt, lead, manganese, and thallium were the inorganic contaminants present in the surface water in maximum concentrations of 147, 37.8, 12.9, 10,100, and 3.3 ug/l, respectively. These analytes were all detected at stations 03 and 04, and all but cobalt were present at station 06.

The inorganic contaminants in the sediment samples includes aluminum, antimony, arsenic, barium, chromium, cobalt, lead, manganese, thallium, and vanadium. Only antimony, lead, and thallium were not found in the sediments of every sample station. Aluminum, arsenic, and barium were found in the highest concentrations at station 05 (maximum concentrations of 7,130, 37.6, and 415 mg/kg, respectively). Chromium, cobalt, and lead were found in the highest concentrations at station 06 (maximum concentrations of 532, 29.9, and 694 mg/kg, respectively). Antimony, manganese, and vanadium were found in the highest concentrations at station 04 (maximum concentrations of 14.1, 4,750, and 118 mg/kg, respectively). Stations 04, 05, and 06 are the stations in Naylor's Run closest to NWP.

Dioxin - As was done for the ground water data, a toxicity equivalent for 2,3,7,8 TCDD was calculated to present the dioxin data for surface water. These data are presented in Figure 4-16. The highest values of 2,3,7,8 TCDD TE were found in the water and sediment just inside and just outside of the catch basin (stations 03 and 04). A 2,3,7,8 TCDD TE of 0.000 was calculated for all other surface

water samples. Values of 2,3,7,8 TCDD TE were 2 to 10 times lower in the sediment at stations 02 and 01 located downstream of the catch basin, compared to values at stations 03 and 04. The value of 2,3,7,8 TCDD TE was 4 times lower at station 05, and 40 times lower at station 06, compared to the values at stations 03 and 04.

One major difference between 1988 and 1990 is that the surface water in 1988 did contain a 2,3,7,8 TCDD TE greater than zero, where it did not in 1990 (Figure 4-17). It is notable that a sediment sample collected in 1988 from the drainage swale immediately north of the NWP property contained a 2,3,7,8 TCDD TE of 20.8. This sample location is equivalent to storm sewer sediment sample 05 (SS-SED-05) in this investigation. However, SS-SED-05 was not analyzed for dioxin isomers in this investigation.

Total Organic Carbon - Sediment samples from stations 08, 09, and 10 in Naylors Run and 01 and 02 from Cobbs Creek were also analyzed for total organic carbon (Table 4-5). The values ranged from 984 to 8580 mg/kg, which are relatively low values. The relatively low total organic carbon is probably related to the large median grain sizes observed for the sediment.

Summary - The surface water sampled contained primarily volatile organic compounds and pentachlorophenol. There has been no significant change in the concentration of VOCs and PCP since 1988. The surface water was largely absent of semi-volatile organic compounds (other than PCP). Four pesticides and 6 metals were detected in levels of potential concern. The surface water had a 2,3,7,8 TCDD Toxicity Equivalent of 0.000 at all locations.

A different picture was generally observed for sediments. In the sediments, PCP was present but contributed only a small fraction of the total concentration of total semi-volatile organic compounds found. The polycyclic aromatic hydrocarbons (PAHs) make up the largest percentage of the semi-volatile organic compounds present. Pesticides and metals were also present in the sediment. Generally, a greater number of pesticides and metals were present in the sediment as compared to the surface water. Values of the 2,3,7,8 TCDD Toxicity Equivalent were, like the surface water, highest in samples stations located inside and

TABLE 4-5
HAVERTOWN PCP SITE
TOTAL ORGANIC CARBON IN SEDIMENT

STATION	CONCENTRATION (mg/kg)
NAY-08	4,850
NAY-09	8,580
NAY-10	3,860
COBB-01	2,450
COBB-02	984

AR300855

immediately outside the catch basin. However, unlike the surface water, dioxin isomers were present in the sediment at all of the sample stations.

4.4 STORM SEWER INVESTIGATION

4.4.1 TV Inspection

The TV inspection of the storm sewer took place on April 3, 1991. The inspection clearly showed that ground water is infiltrating the storm sewer in numerous places between the inlet located on the south corner of the PCG building and the catch basin (Table 4-6). Additionally, it is clear that the storm sewer has acted as a conduit for the transport of either free product or oil-rich water from the staining pattern observed in the sewer. Dark staining was observed at the pipe joints in the section between station 01 and station 02 (Figure 3-4). A transition was noted beginning at station 02 where staining was observed to occur on half the circumference of the pipe. At approximately 65 feet from the catch basin, staining of the entire circumference of the pipe was noted.

Although a minor point, previous investigations (REWAI, 1988) referred to this storm sewer as a 30 inch diameter corrugated metal pipe. The TV inspection revealed that the sewer is primarily constructed of reinforced concrete, with only the last 10 feet prior to the catch basin composed of corrugated metal.

4.4.2 Results of Chemical Sampling

Three water samples and two sediment samples were collected from selected portions of the storm sewer system on the HAVERTOWN site (Figure 4-11). Additional samples had been planned for collection, but no sediment or water was present at these locations (station 01 and station 03).

Volatile Organic Compounds - The compounds benzene, toluene, ethylbenzene, total xylenes, and 2-butanone were detected in the water at station 02A (Figure 4-11). The compounds present, and their concentrations, match closely with those in the ground water observed at cluster wells 4 and 5 and well HAV-04 (Figure 4-5). A low concentration of trichloroethene was detected in the drainage swale adjacent

TABLE 4-6
HAVERTOWN PCP SITE
RESULTS OF TV INSPECTION
OF STORM SEWER

From Station #	To Station #	Distance*	Problems/Comments
2	Outfall	0-166'	Oil stains visible on half circumference of pipe
		11'-45'	Greater depth in water, with smaller flow rate
		68'	Infiltration to bottom right
		166'-231'	Oil stains visible on entire circumference of pipe
2	1	0-245'	Oil stains visible at each pipe joint
		31'	Infiltration to right
		47'	Infiltration to right
		64'	Infiltration at invert
		158'	Longitudinal crack in pipe
		163'	Infiltration to right (major) Flow rate drastically reduced
		234'	Service connection to right
		245'	M.H. #1
1	1A	55'	Service connection to right
		60'	M.H. #1A
1B	1A	9'	Circular crack in pipe
		13'	Longitudinal crack in pipe and in invert
		90'	Longitudinal crack in pipe crown
		165'	M.H. #1A
1B	1C	8'	Hole in pipe at crown
		27'	M.H. #1C

*Distances are from center of upstream station.

AR300857

to NWP. Trichloroethene was also detected in the sediment at station 04, which is downgradient of the drainage swale.

Semi-Volatile Organic Compounds - As was the case with the ground water and surface water samples, PCP (2100 ug/l) in the water sample from station 02A was found to represent almost all of the total semi-volatile organic compounds present. PCP was not observed in any other water sample (Figure 4-13).

The sediment sample collected from the drainage swale adjacent to NWP contained high concentrations of total semi-volatile organic compounds (35,580 ug/kg) and PCP (20,000 ug/kg). However, the total semi-volatile organic compounds were reduced by 75 percent and PCP was reduced to below quantitation limit in the sediment sample collected at station 04. This may indicate that the sediment (containing PCP) is continually flushed through the storm sewer system.

Pesticides and PCBs - None of these compounds were found in the water samples collected from the storm sewer. Aldrin, alpha-chlordane, and gamma-chlordane were detected in the sediment in maximum concentrations of 13, 22, and 29 ug/kg, respectively.

Inorganic Contaminants - Numerous inorganic contaminants were found in the surface water and sediment samples collected from the storm sewer. Aluminum, arsenic, barium, cobalt, lead, and manganese were present in the water and aluminum, arsenic, chromium, cobalt, lead, manganese, mercury, vanadium, and zinc were present in the sediment. All of the inorganic contaminants were present in the sediment at both sampling stations (04 and 05) except for mercury which was present only at station 05.

Dioxin - Analysis of dioxin and its isomers was performed only on the water samples collected from the storm sewer. A toxicity equivalent of 2,3,7,8 TCDD of 0.703 parts per trillion was found at station 02A (Figure 4-16). This again reflects a contribution of ground water into the system.

Summary - Volatile organic compounds, PCP and dioxin were found in a water sample collected from station 02A. The TV inspection of the storm sewer indicated

numerous points of ground water inflow. The presence and concentration of these compounds, mentioned above, reflect the ground water contribution to the water in the storm sewer.

4.5 ECOLOGICAL INVESTIGATION

The ecological investigation evaluated Naylor's Run and Cobbs Creek for potential environmental impacts. Four (4) stations were evaluated; two (2) sample stations in Naylor's Run (HV-EA-08 and HV-EA-10), one (1) sample station below the mixing zone at the confluence of Naylor's Run and Cobbs Creek (HV-EA-C01), and one (1) reference station (HV-EA-C02) along Cobbs Creek above the confluence with Naylor's Run. The results from each sample station will be addressed separately. A detailed listing of the collection is given in Table 4-7. Table 4-8 summarizes the terrestrial vegetation found at each of the sample stations. Ecological field data sheets are found in Appendix F.

4.5.1 Station HV-EA-C02 (Reference Station)

HV-EA-C02 was located on Cobbs Creek approximately 100 feet upstream of the confluence with Naylor's Run. In the area of the sample station, the west bank of the creek ran adjacent to a maintained park. A large sand bar forming a flood plain was located along much of the east bank.

Stream Description

Estimated stream flow was 0.67 m³/s. The stream consisted of approximately 45% riffle, 20% pool and 35% run. Concrete debris was present along parts of the bank. Severe bank erosion was noted, and the east bank showed evidence of recent flooding. Cobble was the dominant riffle/run substrate. Low quantities of coarse particulate organic matter (CPOM) were present. The water was clear, and no noticeable scent was associated with either the water or stream sediment.

AR300859

TABLE 4-7
BENTHIC MACROINVERTEBRATE COLLECTION SUMMARY
HAVERTOWN PCP SITE

STATION (HV-EA-)	08 R/R	08 C	10 R/R	10 C	C01 R/R	C01 C	C02 R/R	C02 C
TURBELLARIA Planariidae							3	
ANNELIDA Oligochaeta Hirundinea Glossiphoniidae	3	3	1	3 1		8	8 1	
CRUSTACEA Isopoda Asellidae Amphipoda Gammaridae	1					2	1	
ARACHNIDA Acari			1			2		
GASTROPODA Physa sp.		2	4	12	1	9	32	10
PELECYPODA								
DIPLOPODA					1			
INSECTA Collembola Entomobryidae	1		1					
Odonata Coenagrionidae							1	
Coleoptera Staphylinidae				1				
Diptera Tipulidae Simuliidae Chironomidae Ephydriidae	14		11		13 1	1 9 1	4 1 7	1 2
Trichoptera Hydropsychidae Philopotamidae					1	19 1	19	1
Osteichthyes Cypinidae Rhinichthys atratulus Catostomidae Catostomus commersoni			2		1	1	2	1
Unknown					1			

R/R: Riffle/Run Samples C: Coarse Particulate Organic Material (CPOM) Samples HV-EA-C02 = Reference Station

AR300860

TABLE 4-8
POTENTIAL RECEPTORS IN THE NAYLORS RUN STUDY AREA

Common Name	Scientific Name	Station No.
PLANTS		
APPLE	<u>Malus sp.</u>	10
BEDSTRAW	<u>Gallium sp</u>	C01
BEECH, AMERICAN	<u>Fagus grandifolia</u>	10
BITTER-CRESS, SMALL- FLOWERED	<u>Cardamine parviflora</u>	10
BOXELDER	<u>Acer negundo</u>	C01,8,10
FOXTAIL	<u>Setaria faberi</u>	C01
GRAPE	<u>Vitis sp.</u>	8
GRASS, BLUE-EYED	<u>Sisyrinchium sp.</u>	C02
GRASS, YELLOW-EYED	<u>Xyris sp.</u>	C02
HONEYSUCKLE, JAPANESE	<u>Lonicera japonica</u>	10
IVY, GROUND	<u>Glechoma hederacea</u>	C01,C02,8
LOCUST, BLACK	<u>Robinia pseudoacacia</u>	10
LOOSESTRIFE, SWAMP	<u>Decodon verticillatus</u>	C02
MAPLE, RED	<u>Acer rubrum</u>	C01
MAPLE, SILVER	<u>Acer saccharinum</u>	C01
MARJORAM, WILD	<u>Origanum vulgare</u>	C01
NETTLE, STINGING	<u>Urtica dioica</u>	C01
ONION, WILD	<u>Allium sp.</u>	C01,10
PENNYCRESS, FIELD	<u>Thlaspi arvense</u>	C01,C02
PHLOX, CREEPING	<u>Phlox stolonifera</u>	C01,C02,8
PLANTAIN, ENGLISH	<u>Plantago lanceolata</u>	10
PRIVIT, COMMON	<u>Ligustrum vulgare</u>	C01
ROSE, MULTIFLORA	<u>Rosa multiflora</u>	C01
SAXIFRAGE, SWAMP	<u>Saxifraga faberi</u>	C01,C02
STRAWBERRY, WILD	<u>Fragaria sp.</u>	8
VIOLET	<u>Viola sp.</u>	8
WALNUT, BLACK	<u>Juglans nigra</u>	10
WINTER-CRESS, COMMON	<u>Barbarea vulgaris</u>	10

AR300861

Terrestrial Vegetation

The banks were partially vegetated, with no canopy cover. The west bank was 90% maintained domestic grasses, plus swamp saxifrage, blue-eyed grass, yellow-eyed grass, field pennycress and swamp loosestrife. No shrubs, woody vines, saplings or trees were observed. The east bank consisted of herbaceous growth that was growing on the flood plain. The vegetation consisted primarily of various grass species, plus creeping phlox and ground ivy.

Terrestrial Wildlife

Evidence of mammalian activity include two muskrat holes in the west bank and the remains of a small mammal (*Peromyscus* sp.) which was found in the adjacent field. Birds observed included blue jay, downy woodpecker, red-tailed hawk and four mallard ducks.

Aquatic Vegetation

Algae was abundant and macrophytes were common. There was no periphyton or slime observed.

Aquatic Wildlife

The riffle/run sample contained the following taxa: one Odonate family (Coenagrionidae), one Trichopteran family (Hydropsychidae), three Dipteran families (Tipulidae, Chironomidae and Simuliidae), one Gastropod (Physidae: *Physa* sp.), one Isopod family (Asellidae), one Leech family (Glossiphoniidae), one Turbellarian family (Planariidae) and Oligochaeta. One species of fish was observed, the black-nose dace (*Rhinichthys atratulus*: Cyprinidae).

The CPOM sample contained the following taxa: one Trichopteran family (Hydropsychidae), two Dipteran families (Tipulidae and Chironomidae), and one Gastropod (Physidae: *Physa* sp.). One white sucker (*Catostomus commersoni*: Catostomidae) was collected dead.

AR300862

Diversity and abundance at this location were comparable to historic investigations and was believed to be representative of the naturally occurring aquatic community of this area. Many of these species are relatively tolerant to poor water quality.

Habitat & Community Evaluation

The habitat evaluation indicates a fair aquatic habitat. Cobbs Creek offers ample attachment sites and riffle/run for a healthy community. Evidence of erosion suggests frequent flooding and scouring along with the associated turbidity. Surface water and sediment chemistry are assumed to be typical of the watershed.

Stream community evaluations will be made by comparing various community parameters at each sample station to the reference station. Eight (8) metrics are used for community comparisons. These metrics are those suggested for use by USEPA (1989). The first seven (7) metrics compare the riffle/run community of the station of comparison with the reference riffle/run community. The eighth metric compares the CPOM community of the station of comparison with the reference CPOM community. The eight metrics are: (1) taxa richness, (2) the modified Family Biotic Index (FBI), (3) the ratio of scrapers to filterers, (4) the EPT (Ephemeroptera, Plecoptera and Trichoptera) to Chironomidae ratio, (5) percent contribution of dominant family, (6) the EPT index, (7) the Community Loss Index (CLI), and (8) the shredder to total population index. The results of all tests are scored as follows: 6 = Non-Impaired; 3 = Moderately Impaired; and 0 = Severely Impaired. The scores are totaled and final assessment of potential impairment is made by comparing the total score of the station to the total of the reference station. More detailed scoring data can be found in Appendix F.

1. Taxa richness is simply defined as the number of taxa (families in our analysis) found at the site. A diverse community (i.e., a high taxa richness) is an indicator of a healthy community. The taxa richness and quality at the reference site indicates a moderately healthy stream community. The reference station (HV-EA-C02) had ten (10) taxa.

AR300863

2. The Family Biotic Index, modified from Hilsenhoff (1982), yields a value of 6.43 for the reference station. This metric is indicative of the sensitivity of the aquatic community to organic pollutants. This value indicates an aquatic community somewhat tolerant to poor water quality.
3. The ratio of scraper and filtering collector functional feeding groups ("scrapers" and "filterers," respectively) reflect the riffle/run community food base. Scrapers are more abundant when there is an abundant periphyton community. Filterers are dominant when there are abundant attachment sights and fine particulate organic material (FPOM). The reference station had thirty-two (32) scrapers and thirty-one (31) filterers. No periphyton was observed, but this may be a seasonal condition. The scrapers may be utilizing algae as a food source.
4. The ratio of EPT to Chironomid abundance is a metric of community structure. Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) are sensitive to water quality. The Chironomidae (midges) can be quite tolerant to poor water quality. A strong representation of EPT indicates a healthy community, but a strong representation of Chironomidae suggests impairment. The reference station had a ratio of 19/7 (value = 2.7) indicating a healthy community.
5. The percent contribution of the dominant family is a metric that indicates community balance. In many cases a community with few dominant taxa is indicative of environmental stress. The dominant family at the reference station made up 42% of the total number of organisms. The moderately high percent contribution is typical in tolerant aquatic communities. The absence of sensitive species enable more tolerant species to fill empty niches.
6. The EPT index is a metric that increases as water quality improves. The EPT index value summarizes the taxa richness within the insect groups that are generally pollution sensitive. The reference station has an EPT index value of 1. This value is poor indicating a lack of sensitive families.

AR300864

7. The CLI is a measure of dissimilarity that assesses the loss of benthic taxa between the reference and a station of comparison. Increased dissimilarity reflects a community shift that could potentially be brought on by the loss of sensitive taxa due to ecological stress. A higher CLI value indicates greater dissimilarity. A CLI value can not be calculated for the reference station alone because it is a relative value.
8. The ratio of individuals in the shredder functional feeding group ("shredders") versus total individuals collected is a metric used to measure impairment of the CPOM shredder community. A lower value indicates greater impairment. The ratio at the reference station was 1/14 (value = 7%). This is considered a poor ratio. The low value is not surprising since little CPOM was present in Cobbs Creek.

4.5.2 Station HV-EA-08

HV-EA-08 was located in Washington Park approximately one half mile downstream from the oil/water separator on Naylors Run. The area surrounding the sample station consists of a small community park on the north bank, and a combination of open and wooded residential properties on the south bank.

Stream Description

Estimated flow was $0.02 \text{ m}^3/\text{s}$. The morphology of the stream of the station was non-supportive of the reference station's benthic community. The stream consisted of approximately 70% run and 30% riffle, with an approximate 30% canopy cover. Erosion was apparent on the north bank. The south bank was channelized by a mortar and stone wall. The dominant riffle/run substrate was cobble. Detritus was present in large amounts, however, decomposition was poor. An iron flocculent was present on some of the cobble in minimal amounts. A white flocculent was present on some of the detritus, but it did not appear to be organic (fungi). The water had an oily scent and a slight oil sheen on it's surface. The sediment had a similar, but more noticeable scent.

AR300865

Terrestrial Vegetation

The vegetation of the north bank is dominated by domestic grasses. The south bank ground cover consists of patches of moss. Herbs include domestic grasses, ground ivy, creeping phlox, violets and wild strawberry. Grape was the only woody vine observed. Boxelder was the dominant tree species at the station.

Terrestrial Wildlife

Gray squirrel was the only mammal observed near the station. A hole which appeared to be an old abandon muskrat hole was also observed. Birds observed included a tufted titmouse and downy woodpecker.

Aquatic Vegetation

No periphyton was observed. Slime was present, but rare. Filamentous algae was dominant at the sample station and covered the majority of the substrate. Macrophytes were rare.

Aquatic Wildlife

The riffle/run macroinvertebrate collection yielded very few organisms, both in numbers and in diversity. One Dipteran family (Chironomidae), one Collembolan family (Entomobryidae), one Amphipod family (Gammaridae) and Oligochaetes were collected.

The CPOM collection yielded one Gastropod (Physidae: *Physa* sp.) and Oligochaetes. The aquatic community is dominated by tolerant species. No fish were observed at the sample station.

Comparison to Reference

The habitat at station HV-EA-08 is non-supportive of the reference station's benthic community. Channelization and severe flushing during storm events further impair the stream.

1. The four (4) families of macroinvertebrates in the riffle/run sample were taxa that are relatively tolerant to poor water quality. The taxa richness of this station indicates a severely impaired aquatic community.
2. The modified FBI gave a value of 6.35. The FBI at this station is comparable to the reference station.
3. No scrapers and fourteen (14) filterers were present at the sample station. This supports the lack of periphyton observed. The filterers are suspected to be attached to the filamentous algae. The above numbers indicate severe impairment.
4. No EPT were collected at this station resulting in an EPT/Chironomidae ratio was 0/14 (value = 0). This indicates a severely impaired community.
5. The percent contribution of the dominant family was 67%. This indicates a poor community balance typical of a stressed community.
6. The EPT index value was 0, indicating a severely impaired community.
7. The CLI value was fairly high at 2.0. Again, this is indicative of a moderately impaired community.
8. The ratio of shredders to total organisms collected was 0/5 (value = 0), suggesting community stress.

The overall ecological assessment of the aquatic community indicates severe impairment of the aquatic community at this station.

4.5.3 Station HV-EA-10

HV-EA-10 was located in the vicinity of the access road located within a small park, immediately west of the Garrett Road crossing over Naylor's Run. This location is located approximately 1.7 miles upstream of the confluence of Naylor's

AR300867

Run and Cobbs Creek. The sample station was located within a sparsely wooded portion of a park. Small sections of open field were present.

Stream Description

Estimated flow was 0.36 m³/s. Compared to the reference station, this stream section was considered to have a comparable habitat. This indicates that the habitat at this station was expected to support organisms similar to those of the reference station. There was a concrete throughway within the sampling area, however, little disturbance was associated with it. Naylor's Run was channelized approximately one hundred yard upstream. The stream consisted of approximately 45% riffle, 5% pool and 50% run. Cobble is the dominant inorganic substrate. The stream had an approximate 40% canopy cover.

The water was clear and the sediment normal. Along portions of the bank, detritus was present, but decomposition of the leafy matter was limited.

Terrestrial Vegetation

The north bank ground cover consisted predominantly of mosses, wild onion, and English plantain. Japanese honeysuckle was the dominant woody vine, with American beech and apple being the dominant trees. The vegetation was not indicative of wetlands.

The south bank ground cover consisted of common wintercress, small-flowered bitter-cress, wild onion and domestic grasses. Saplings consisted of black locust, black walnut and boxelder. The vegetation was not indicative of wetlands.

Terrestrial Wildlife

Observed terrestrial wildlife included the gray squirrel and eastern striped skunk. Birds included the downy woodpecker, tufted titmouse, American crow and house finch.

AR300868

Aquatic Vegetation

Filamentous algae was abundant at this station, however, it was not as dominant as it was at HV-EA-08. No other aquatic vegetation was present.

Aquatic Wildlife

The riffle/run macroinvertebrate collection yielded a low diversity and number of organisms. The following was collected: one Dipteran family (Chironomidae), one Collembolan family (Entomobryidae), one Arachniodean family (Oxidae), one Gastropod (Physidae: *Physa* sp.) and Oligochaetes.

The CPOM sample yielded one Coleopteran family (Staphylinidae), one Pelecypod family (Sphaeriidae), one Gastropod (Physidae: *Physa* sp.), one Hirudinean family (Glossiphoniidae) and Oligochaetes.

An abundance of black-nose dace were found at the sample station. There was also a large number of chironomid exuvia found. This suggests that there was an emergence prior to sampling, and that the chironomids are most likely to be the primary food source for the dace.

Comparison to Reference

Comparison with the reference station indicates that station HV-EA-10 has a comparable habitat for the reference station organisms. Stream flow at HV-EA-10 is approximately half of the reference station flow.

1. There were five (5) relatively tolerant families of macroinvertebrates in the riffle/run sample. The low taxa richness indicates a moderately impaired aquatic community when compared to the reference station.
2. The modified FBI gave a value of 6.78. This is comparable to the tolerant community at the reference station.

AR300869

3. Four (4) scrapers and twelve (12) filterers were collected at the station yielding a value of 0.33. This indicates moderate impairment when compared to the reference station.
4. No EPT were collected at this station, yielding an EPT:Chironomidae ratio of 0/11 (value = 0). This indicates a severely impaired community.
5. The percent contribution of the dominant family was 55%. This indicates a poor community balance, typical of a stressed community.
6. The EPT index value was 0, indicating a severely impaired community.
7. The CLI had a value of 1.4. This is indicative of a moderately impaired community.
8. The ratio of shredders to total organisms was 0/18 (value = 0), suggesting community stress.

The overall ecological assessment of the aquatic community indicates moderate to severe impairment at this station.

4.5.4 Station HV-EA-C01

HV-EA-C01 was located immediately downstream of the confluence of Naylor's Run and Cobbs Creek. The area surrounding the sample station consisted of an open field on the west bank and a dirt road on the west bank. A narrow band of sparse woods ran immediately adjacent to both banks.

Stream Description

Estimated flow was 0.95 m³/s. This stream section was considered to have a habitat comparable to that of the reference station. The stream consisted of approximately 70% riffle, 0% pool and 30% run. The stream substrate was dominated by cobble. The stream had approximately 20% canopy cover.

AR300870

The water had no scent and was clear. The sediment had no noticeable scent. The banks consisted of vegetation, earth and concrete debris. The debris appears to have been placed along the banks for erosion control, however, erosion was still evident. Little detritus was present but evidence of decomposition was observed.

Terrestrial Vegetation

The ground cover on the east bank consisted of stinging nettle, multiflora rose, ground ivy, wild marjoram, foxtail, swamp saxifrage, field pennycress and domestic grasses. The only shrub observed was privet. Saplings included boxelder and red maple, with boxelder the only tree observed. The terrestrial vegetation was not indicative of wetlands.

The ground cover on the west bank consisted of wild onion, field penny cress, ground ivy, creeping phlox, bedstraw and domestic grass. The west bank was dominated by grasses maintained by the park. Tree species included boxelder, red maple and silver maple. The terrestrial vegetation was indicative of potential jurisdictional wetlands. If wetlands do exist, they would most likely be immediately along the bank.

Terrestrial Wildlife

The wildlife observed at this station consisted of the following birds: red-bellied woodpecker, tufted titmouse, house finch, kingfisher, mourning dove and four (4) mallard ducks.

Aquatic Vegetation

There was no observed periphyton and slime was rare. Filamentous algae and macrophytes were common.

Aquatic Wildlife

AR300871

The riffle/run sample consisted of the following: one Trichopteran family (Hydropsychidae), two Dipteran families (Chironomidae and Simuliidae), one Diplopod, one Gastropod (Physidae: *Physa* sp.) and one unknown.

The CPOM sample included two Trichopteran families (Philopotamidae and Hydropsychidae), three Dipteran families (Chironomidae, Simuliidae and Ephydriidae), one Gastropod (Physidae: *Physa* sp.), one Mite (Arachnida: Acari) one Isopod family (Asellidae) and Oligochaetes.

Fish were common at this station. Black-nose dace were dominant.

Comparison to Reference

This station had a comparable habitat for the reference station organisms. The little bank cover was similar to that of the reference station.

1. There were five (5) relatively tolerant families of macroinvertebrates in the riffle/run sample. The low taxa richness indicates a moderately impaired aquatic community when compared to the reference station.
2. The modified FBI gave a value of 6.40. This is comparable to the tolerant community at the reference station.
3. One (1) scraper and three (3) filterers were collected at the station yielding a value of 0.33. This indicates moderate impairment when compared to the reference station.
4. One EPT was collected at this station, yielding an EPT:Chironomidae ratio of 1/1 (value = 1). This indicates a moderately impaired community.
5. The percent contribution of the dominant family was 17%. This indicates community balance.
6. The EPT index value was 1, which is comparable to the reference station.

AR 80087.2

7. The CLI had a value of 1.0. This is indicative of a moderately impaired community.
8. The ratio of shredders to total organisms was 0/52 (value = 0), suggesting community stress.

The overall ecological assessment of the aquatic community indicates moderate impairment of the aquatic community at this station.

4.5.5 Summary

The terrestrial vegetation appears to be typical of stream bank vegetation found in the area. The benthic macroinvertebrate community in Naylor's Run improves with distance downstream from the Havertown PCP Site. The reference station appears typical of the watershed. Streams within this area appear subjected to severe scouring and erosion resulting from large volumes of urban surface runoff. Little FPOM was noticed at any of the sample locations, which may explain the lack of filterers in the benthic community. The benthic communities lack sensitive organisms, attributable to surface runoff and the poor-to-fair stream habitat. Additionally, historic contamination from the Havertown PCP Site is a major cause of the poor benthic community in Naylor's Run and in Cobbs Creek below its confluence with Naylor's Run. It should be noted, however, that the benthic community within Naylor's Run and Cobbs Creek has improved compared to historic studies.

AR300873

LEGEND:

--300.00-- POTENTIOMETRIC LEVEL CONTOURS
300.00 GROUND WATER ELEVATION (FT. ABOVE M.S.L.)



AR300874

TCH 4212
R1 REPORT
REV. #1
24/JUN/91

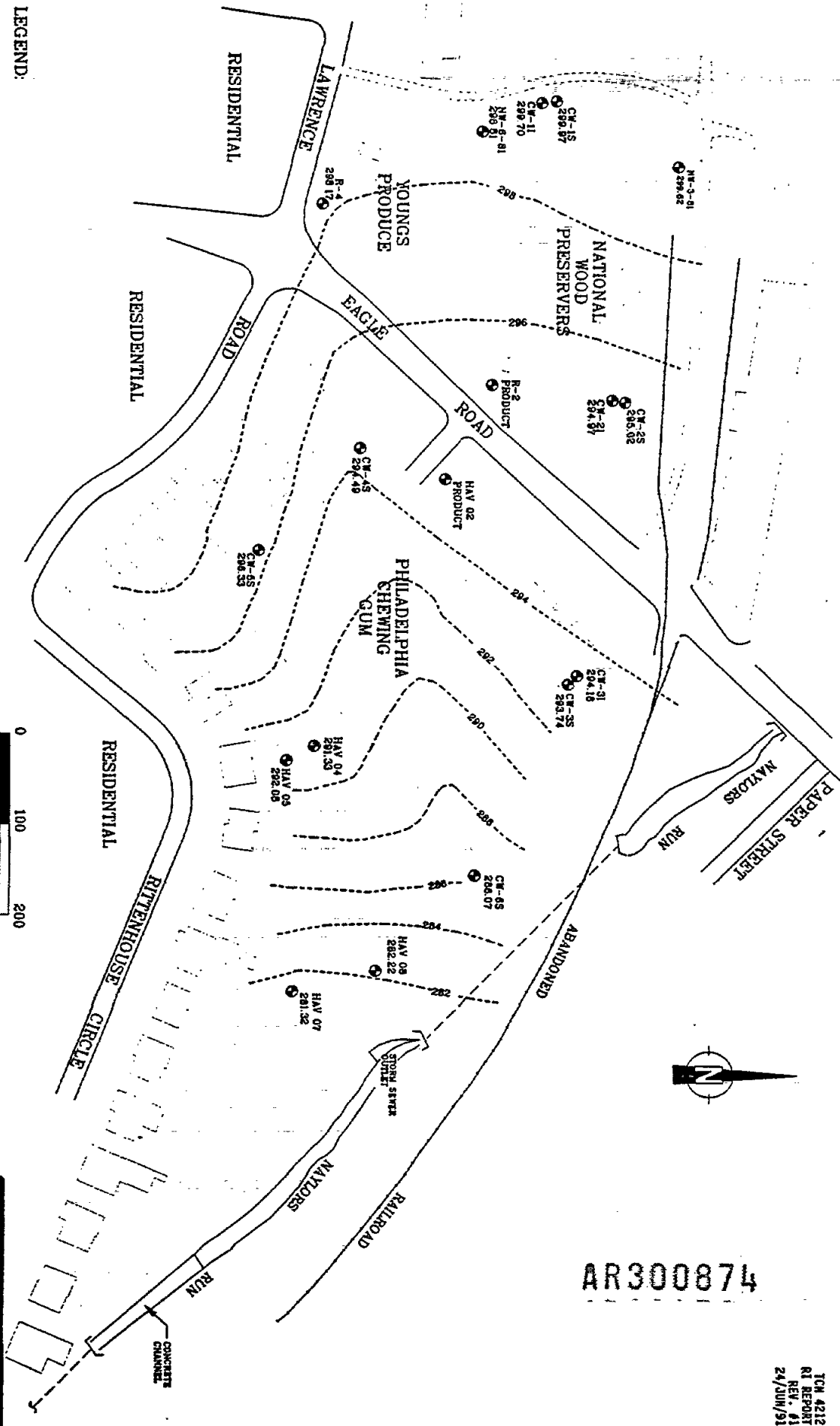


FIGURE 4-3
MAYTOWN PCP SITE
WATER LEVEL
SHALLOW
100' ZONE
SEPT 21, 1991

LEGEND:
 --- POTENTIOMETRIC LEVEL CONTOURS
 300.00 GROUND WATER ELEVATION (FT. ABOVE M.S.L.)

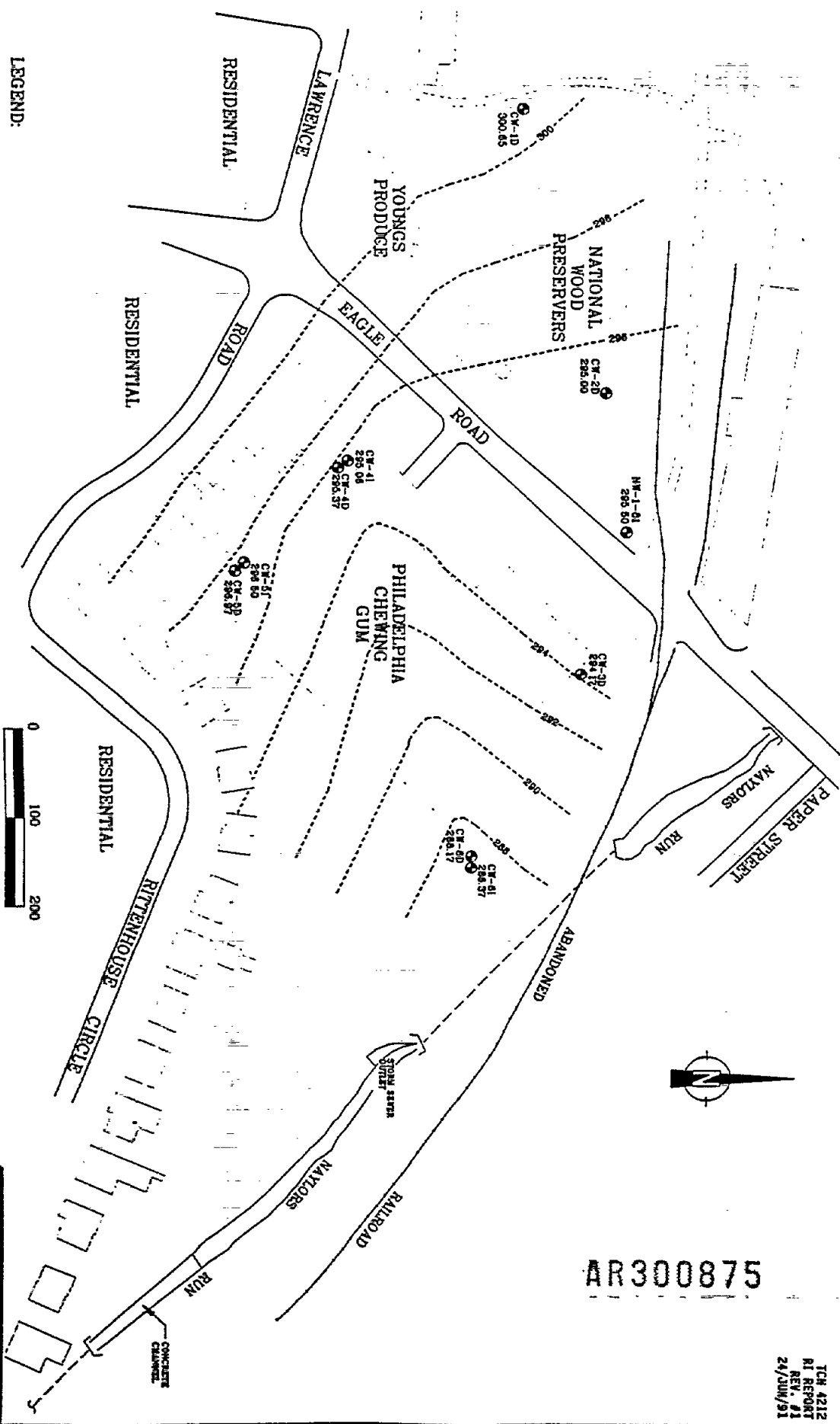


AR300875

TCH 4212
 RI REPORT
 REV. #1
 24/JUN/91

TE TERRA TECH, INC.

FIGURE 4-4
 DRAINAGE FOR SITE
 WATER LEVEL DATA
 DEEP HYDROLOGIC ZONE
 SEPT 21, 1990

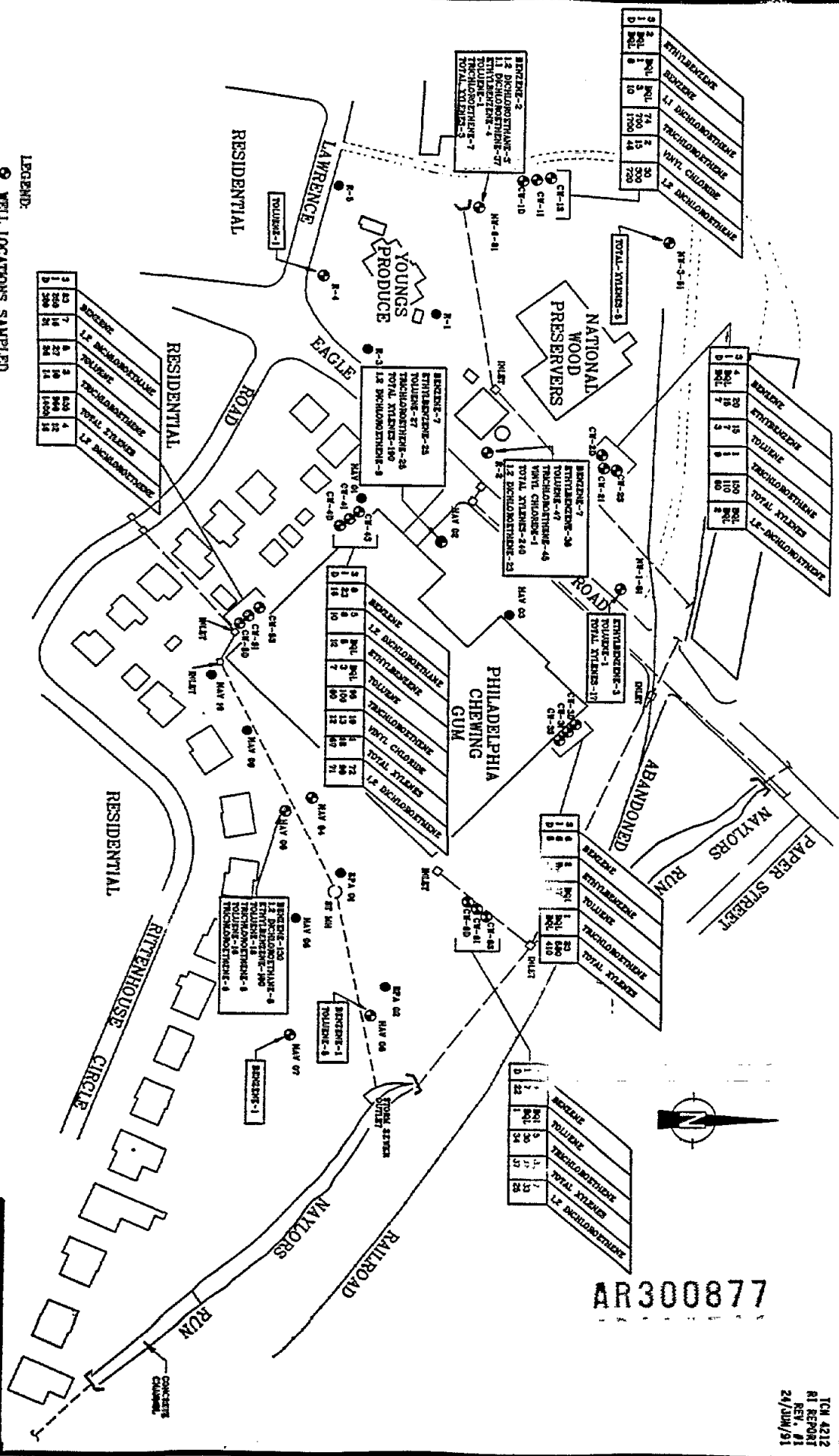


LEGEND:
 ● WELL LOCATIONS SAMPLED
 BQL BELOW QUANTITATION LIMIT
 UNITS IN UG/L

SOURCE: REMAL, 1988



TECHNICAL, INC.
 TOWN 4-4
 HAZARDOUS WASTE SITE
 VOLATILE ORGANIC COMPOUNDS
 DETECTED IN GROUND WATER
 1988



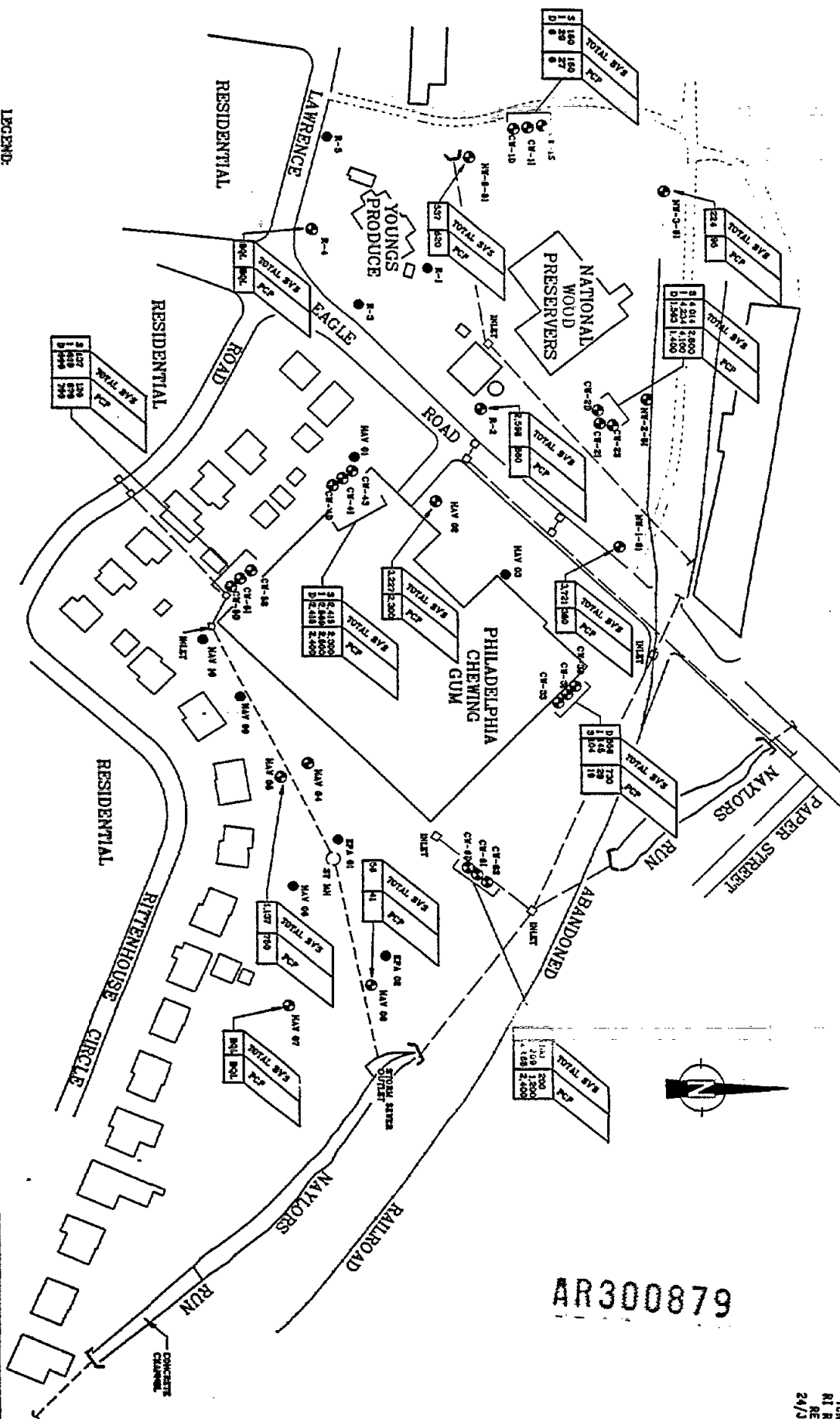
AR300877

TCN 4212
 RI REPORT
 REF. #1
 24/JUN/91

LEGEND:
 ● WELL LOCATIONS SAMPLED
 BQL BELOW QUANTITATION LIMIT
 SV SEMI-VOLATILE ORGANICS
 UNITS-ug/l

SOURCE: REMVAL, 1985

0 100' 200'
 SCALE



AR300879

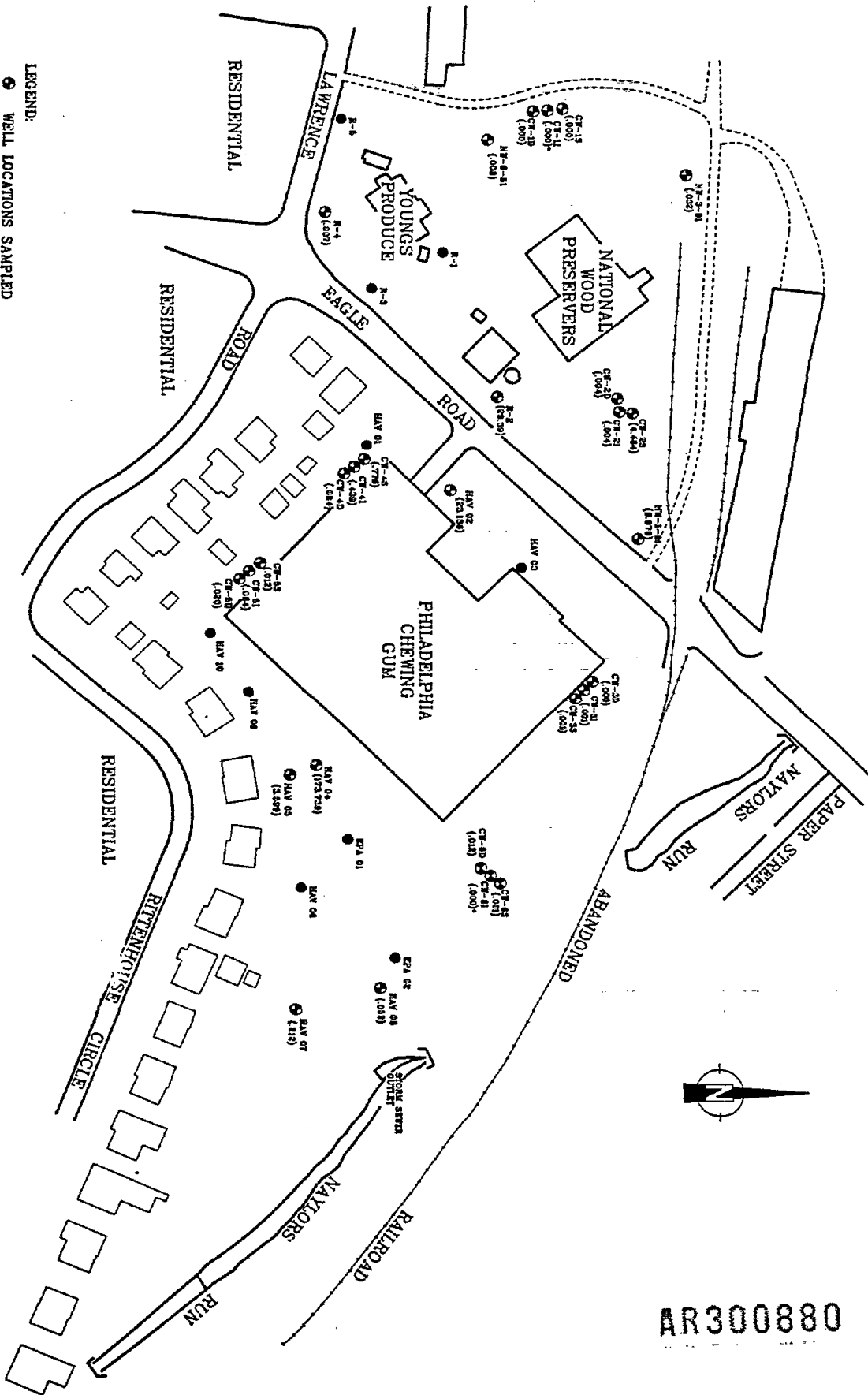
TON 4212
 RI REPORT
 REV. #1
 24/JUN/91

TECHNICAL INC.
 FIGURE 4-1
 REMEDIAL ACTION SITE
 SEMI-VOLATILE ORGANICS
 DETECTED IN GROUND WATER
 1985

- LEGEND:
- WELL LOCATIONS SAMPLED
 - OTHER WELL LOCATIONS
 - * DUPLICATE ANALYSIS - RESULTS ARE AVERAGED
- UNITS ARE PARTS PER TRILLION (ppt)

0 100' 200'
SCALE

TECHNICAL INC.
FIGURE 4-5
PAVING AND PCP SITE
DOWN
DETECTED IN GROUND WATER
NOV 7-15

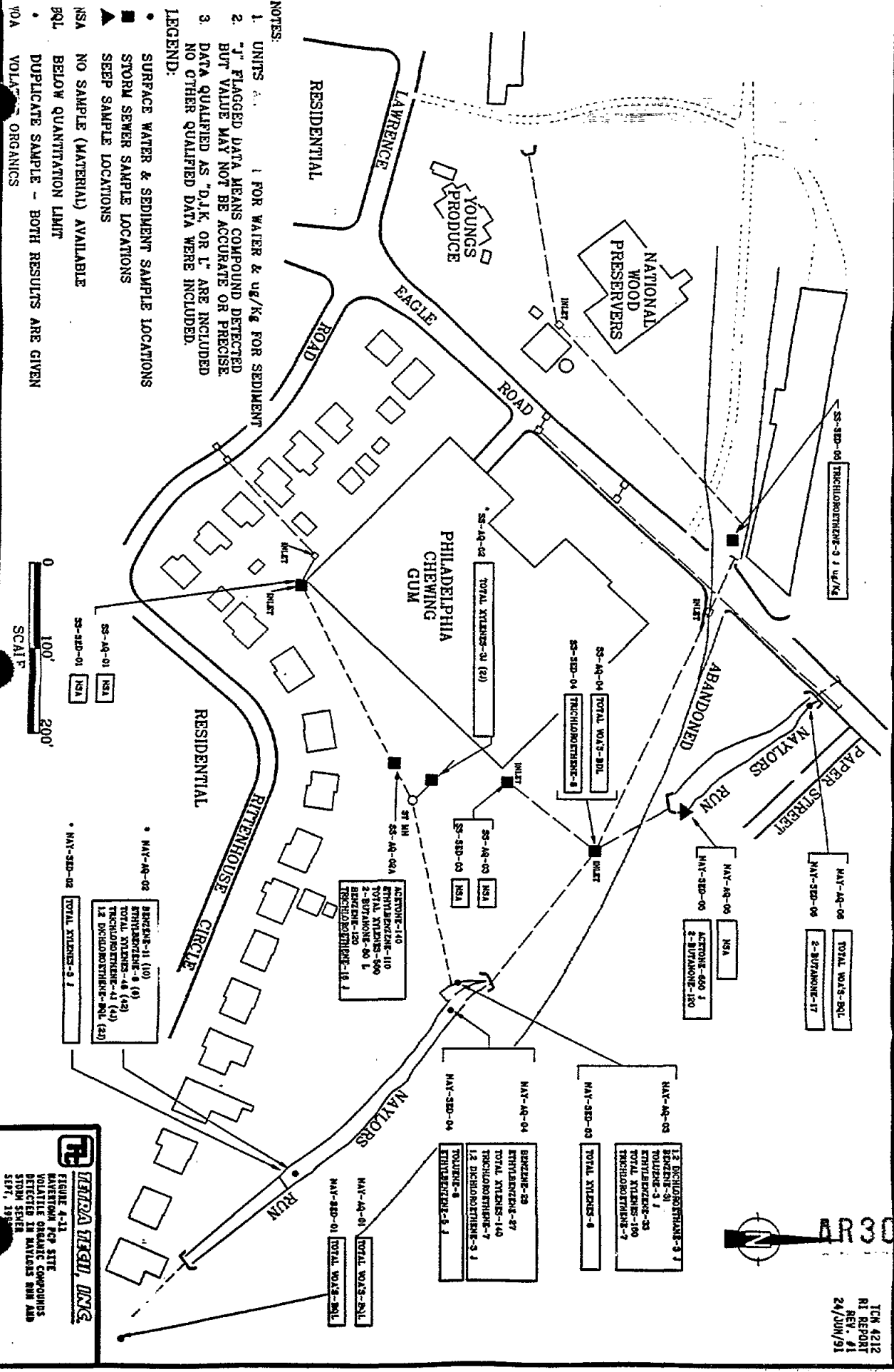


AR300880

TCH 4212
RI REPORT
REV. 41
24/JUN/91

TCN 4212
RI REPORT
REV. #1
24/JUN/91

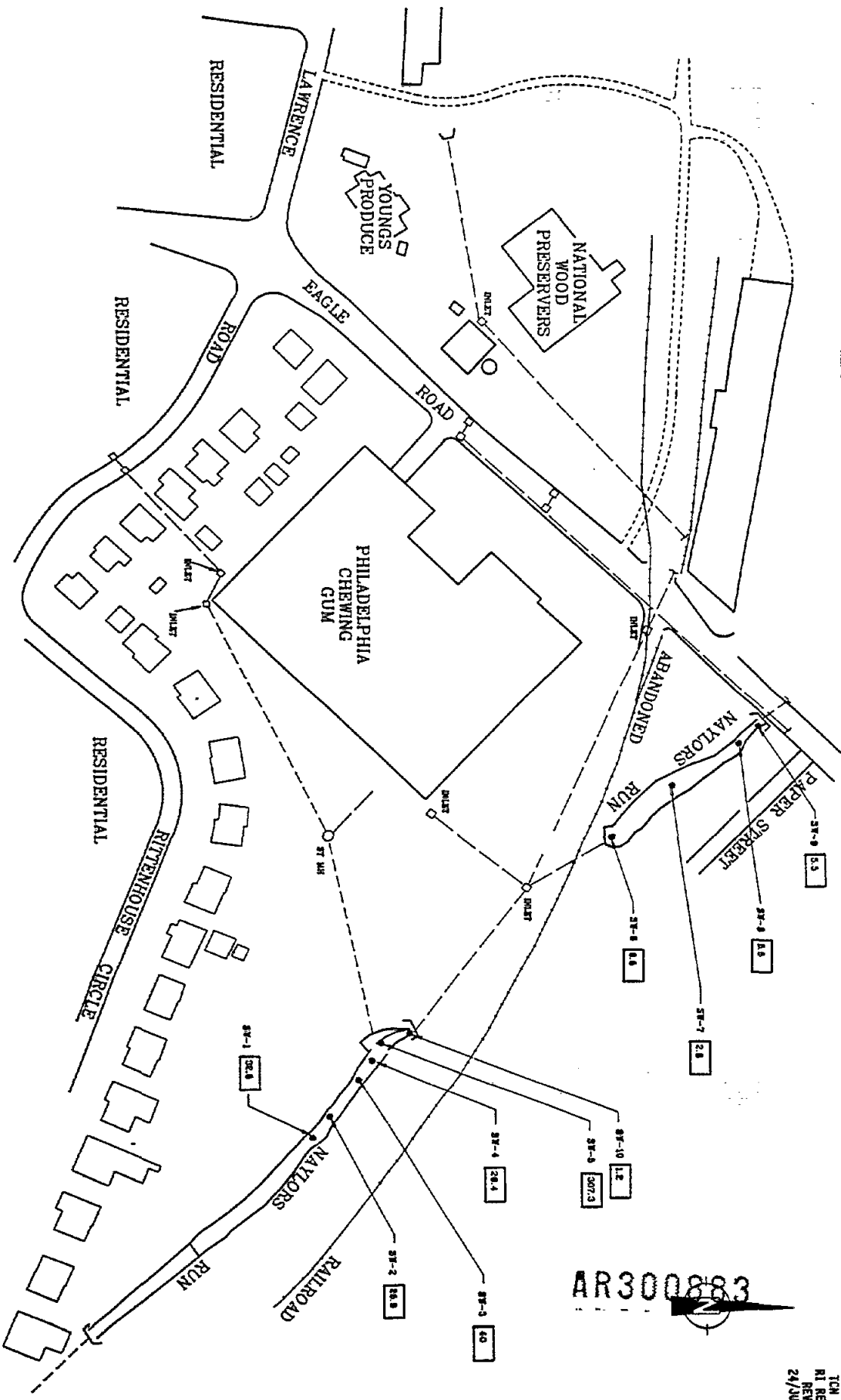
AR300882



TECHNICAL, INC.
FIGURE 4-31
MATERIAL FOR SITE
VOLATILE ORGANIC COMPOUNDS
DETECTED IN NAYLOR'S RUN AND
SEPT. 1990

TCN 4212
RI REPORT
REV. #1
24/JUN/91

AR300883



LEGEND:

- SURFACE WATER & SEWERING SAMPLE LOCATIONS
- BELOW DETECTION LIMIT
- DUPLICATE SAMPLE - RESULTS ARE AVERAGED
- UNIT: 100' IN 1"

SOURCE: SERIAL 1948



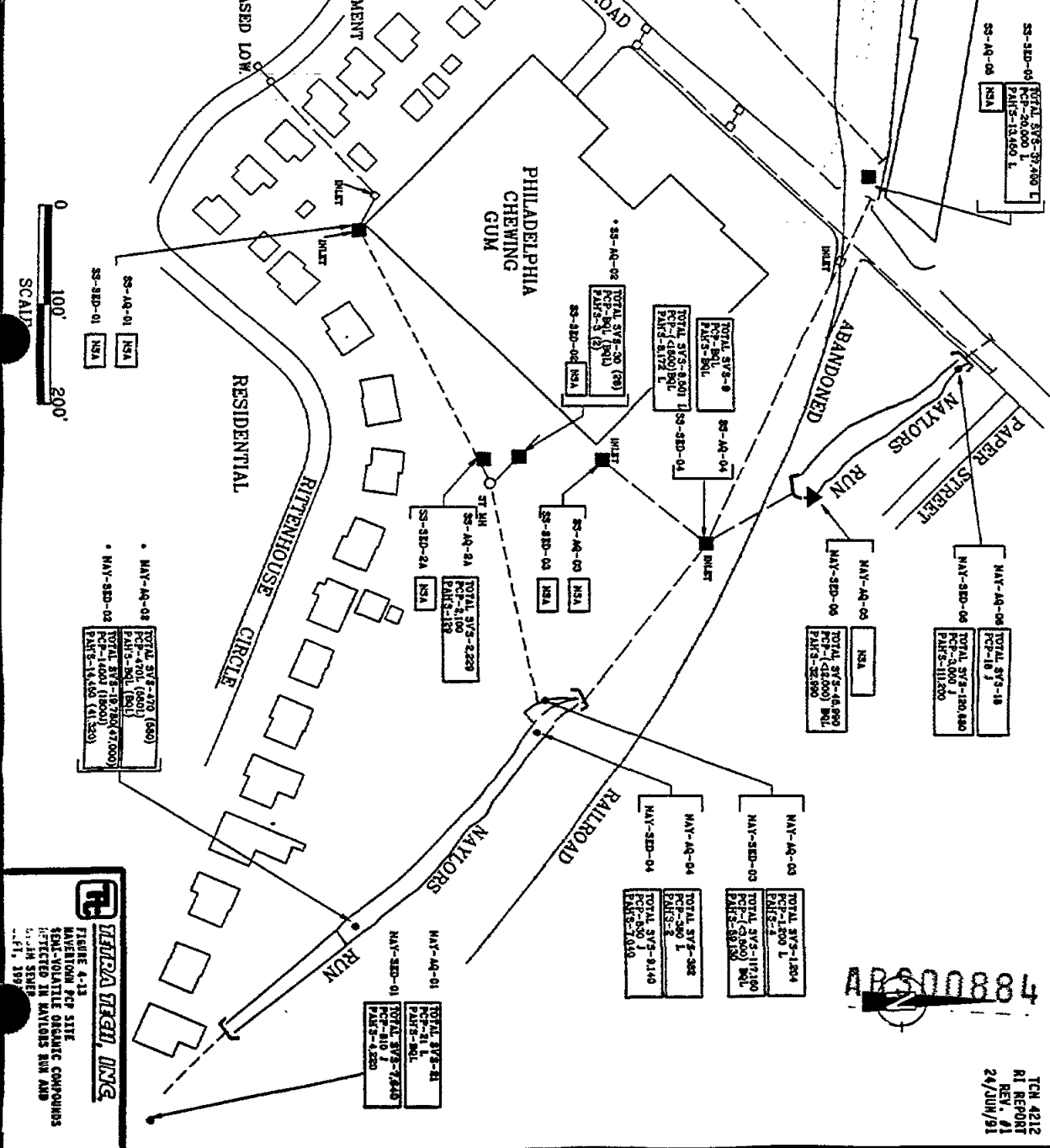
SCALE



TERRA TECH, INC.

TRIMBLE 4-12
HAWKINS FCZ SITE
TOTAL VOLATILE ORGANIC COMPOUNDS
DETECTED IN EXTRACTS FROM
1998

- NOTES:
1. UNITS ARE IN $\mu\text{g/l}$ FOR WATER & $\mu\text{g/kg}$ FOR SEDIMENT
 2. DATA QUALIFIED AS "D.J.K. OR L" ARE INCLUDED
 3. "J" FLAGGED DATA MEANS COMPOUND DETECTED BUT VALUE MAY NOT BE ACCURATE OR PRECISE
 4. "L" FLAGGED DATA MEANS REPORTED VALUE IS BIASED LOW
- LEGEND:
- ◆ SURFACE WATER & SEDIMENT SAMPLE LOCATIONS
 - STORM SEWER SAMPLE LOCATIONS
 - ▲ SEEP SAMPLE LOCATIONS
 - NO SAMPLE (MATERIAL) AVAILABLE
 - NSA BELOW QUANTIFICATION LIMIT
 - DUPLICATE SAMPLE - BOTH RESULTS ARE GIVEN
 - SV SEMI-VOLATILE ORGANICS
 - PAH'S POLY AROMATIC HYDROCARBONS

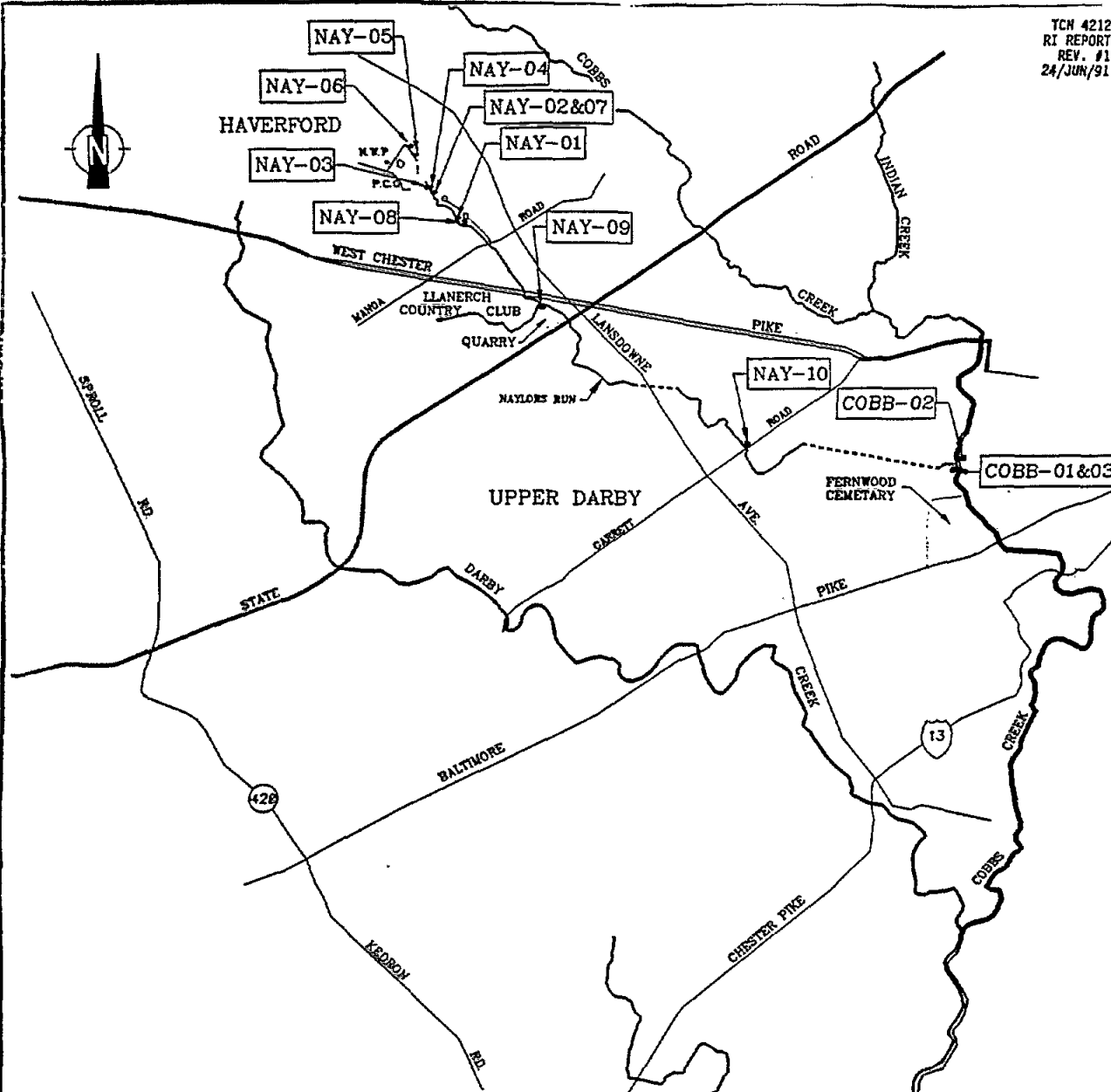


AR500884

TCN 4212
RI REPORT
REV. #1
24/JUN/91

TECHNICAL INC.

FIGURE 4-13
INVENTION FOR SITE
SEMI-VOLATILE ORGANIC COMPOUNDS
DETECTED IN NAYLORS RUN AND
ADJACENT AREAS



SAMPLE LOCATION	WATER			SEDIMENT		
	PCP	TOTAL SEMI-VOLATILES	PAH'S	PCP	TOTAL SEMI-VOLATILES	PAH'S
NAY-01	21 L	21	BQL	810 J	7,640	4,220
NAY-02	470 L	470 L	BQL	1,400 J	19,780	14,450
NAY-02(DUP)	580 L	580 L	BQL	1,800 J	47,000	43,120
NAY-03	1,200 L	1,204	4	BQL (3,800)	117,160	59,130
NAY-04	380	382	2	830 J	9,140	7,040
NAY-05	NSA	NSA	NSA	BQL (12,000)	45,990	32,990
NAY-06	18 J	18 J	BQL	3,000 J	120,680	111,200
* NAY-08	140	140	BQL	360 J	43,206	40,830
NAY-09	25	25	BQL	BQL (1,000)	13,708	11,503
* NAY-10	6 J	6 J	BQL	BQL (1,100)	84,634	81,110
* COBB-01	3 J	3 J	BQL	BQL (950)	5,445	5,296
COBB-01(DUP)	2 J	2 J	BQL	BQL (990)	5,822	5,308
* COBB-02	BQL (25)	BQL	BQL	BQL (1,000)	1,817	1,786

* BENTHIC MACROINVERTEBRATE SAMPLE LOCATIONS

NOTE:
UNITS ARE IN $\mu\text{g}/\text{kg}$ FOR SEDIMENT
AND $\mu\text{g}/\text{L}$ FOR WATER

LEGEND:

- SEPT 1990 SAMPLE LOCATIONS
- JAN 1991 SAMPLE LOCATIONS
- NSA NO SAMPLE MATERIAL AVAILABLE
- BQL BELOW QUANTITATION LIMIT
- (00) QUANTITATION LIMIT
- J REPORTED VALUE - NOT ACCURATE OR PRECISE
- L REPORTED VALUE - BIASED LOW

AR300885



TETRA TECH, INC.

FIGURE 4-14
HAVERFORD PCP SITE
SEMI-VOLATILE ORGANIC COMPOUNDS
DETECTED IN NAYLOR'S RUN AND
COBB CREEK
SEPT. 1990 AND JAN. 1991

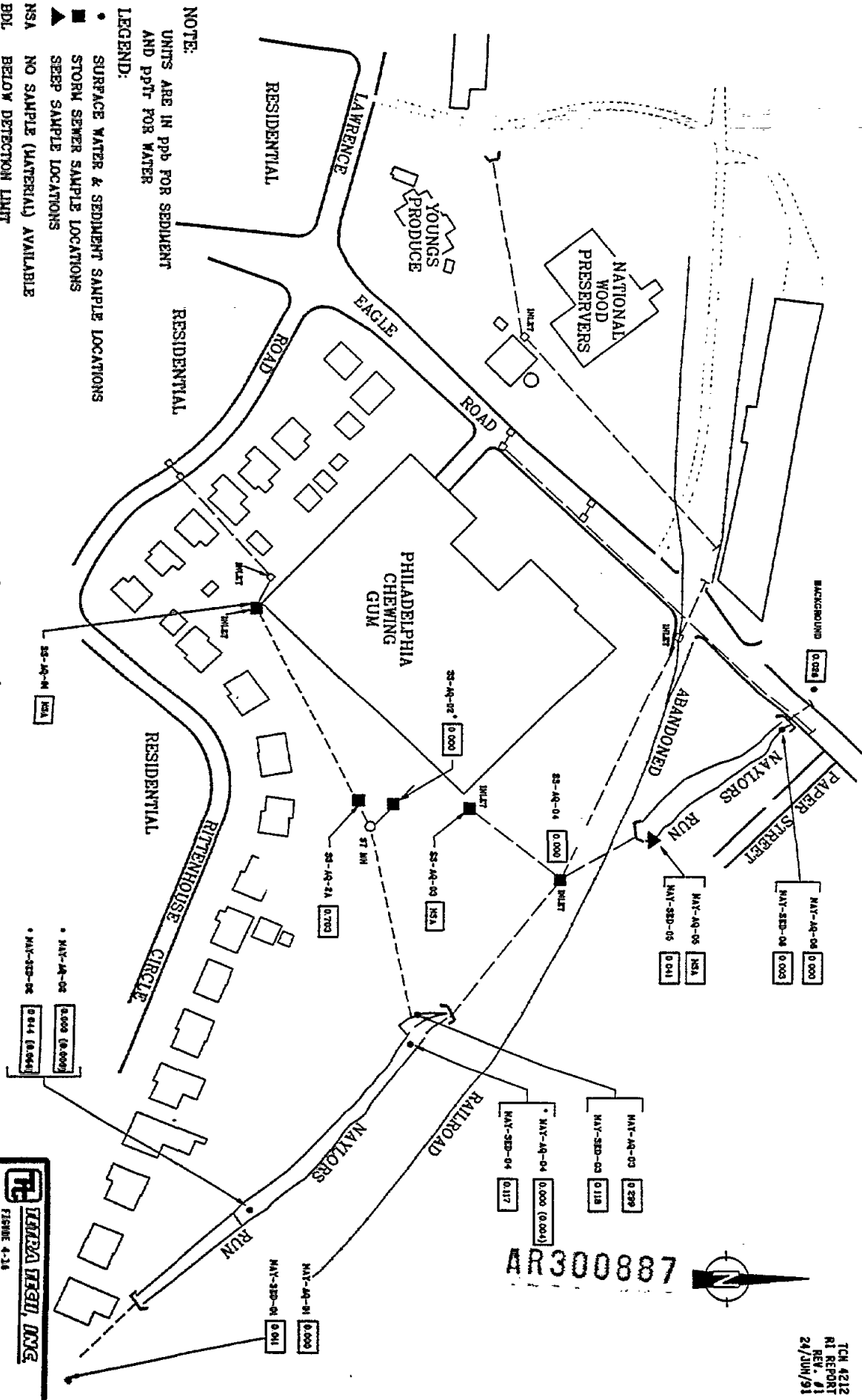
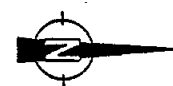
AR 3 ~~2298~~

TELEBA TECH, INC.

FIGURE 4-15
MAVERICK PCP SITE
SEMI-VOLATILE ORGANIC COMPOUNDS
DETECTED IN RAILROAD RUN
1998

TCH 4212
RI REPORT
REV. 01
24/JUN/91

AR300887



NOTE:
UNITS ARE IN PPB FOR SEDIMENT
AND PPT FOR WATER

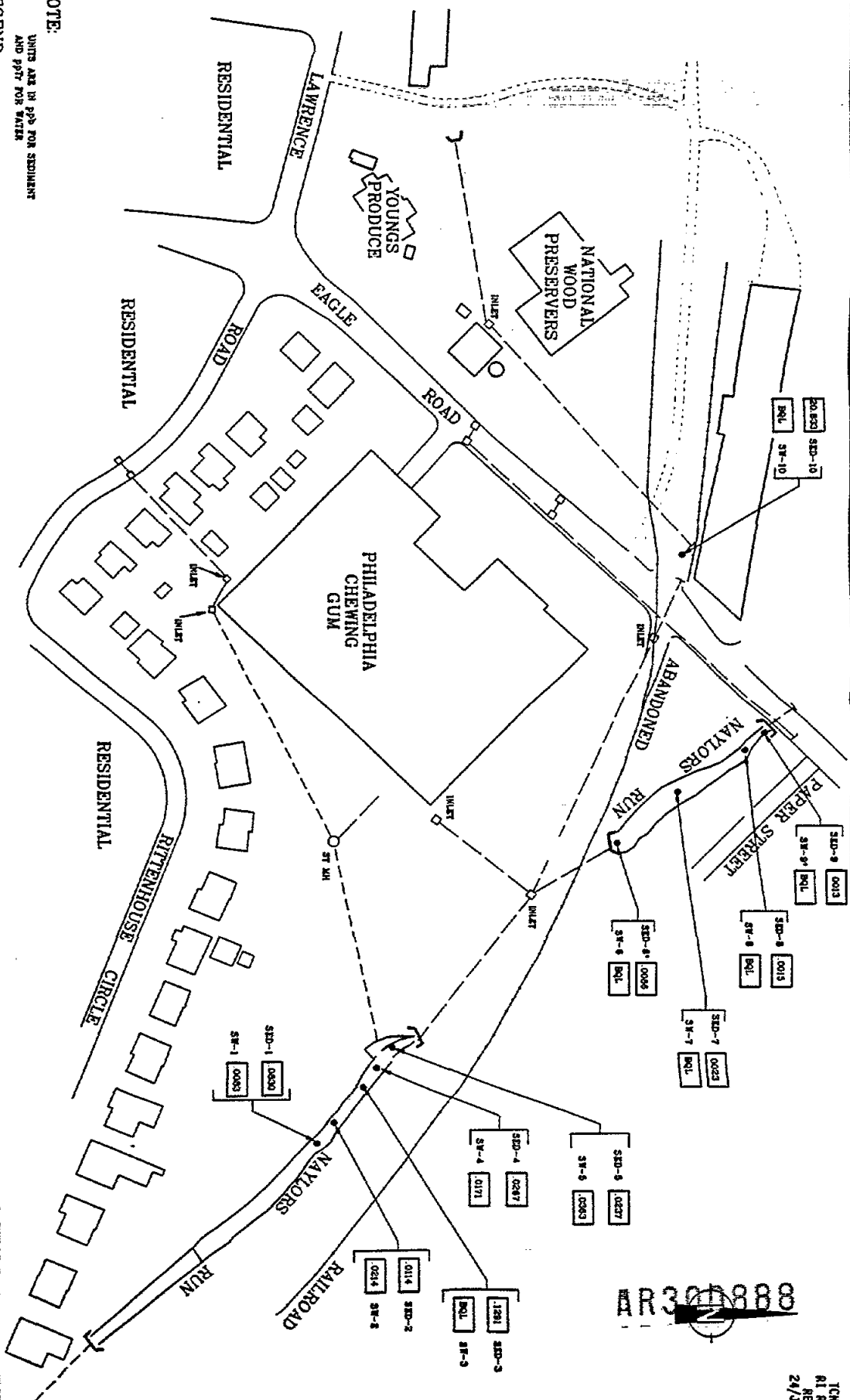
- LEGEND:
- SURFACE WATER & SEDIMENT SAMPLE LOCATIONS
 - STORM SEWER SAMPLE LOCATIONS
 - ▲ SEEP SAMPLE LOCATIONS
 - NSA NO SAMPLE (MATERIAL) AVAILABLE
 - BDL BELOW DETECTION LIMIT
 - * DUPLICATE SAMPLE - RESULTS ARE BOTH GIVEN

0 100' 200'
SCALE

TECHNICAL DRAWING
FIGURE 4-16
DIVISION FOR SITE
WATER DETECTED IN NAYLOR'S RUN
AND SEEP SAMPLE (1000 TRL. EQUIV.)
SEPT. 1990

TCN 4212
 RI REPORT
 REV. 41
 24/JUN/91

AR300888



NOTE:
 UNITS ARE IN PPM FOR SEDIMENT
 AND PPM FOR WATER

LEGEND:

- SURFACE WATER & SEDIMENT SAMPLE LOCATIONS
- BELOW QUANTIFICATION LIMIT
- DUPLICATE SAMPLE - RESULTS ARE AVERAGED

SOURCE: REVAL 1988

0 100' 200'
 SCALE



TERRA TECH, INC.

FIGURE 4-17
 HAZARDOUS PCP SITE
 DIOXIN RESULTS DETECTED IN
 HAYLOWS RUN (TCN TOX. EQVIV.)
 1988

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 POTENTIAL ROUTES OF MIGRATION

The potential routes of migration of contaminants at the HAVERTOWN site include:

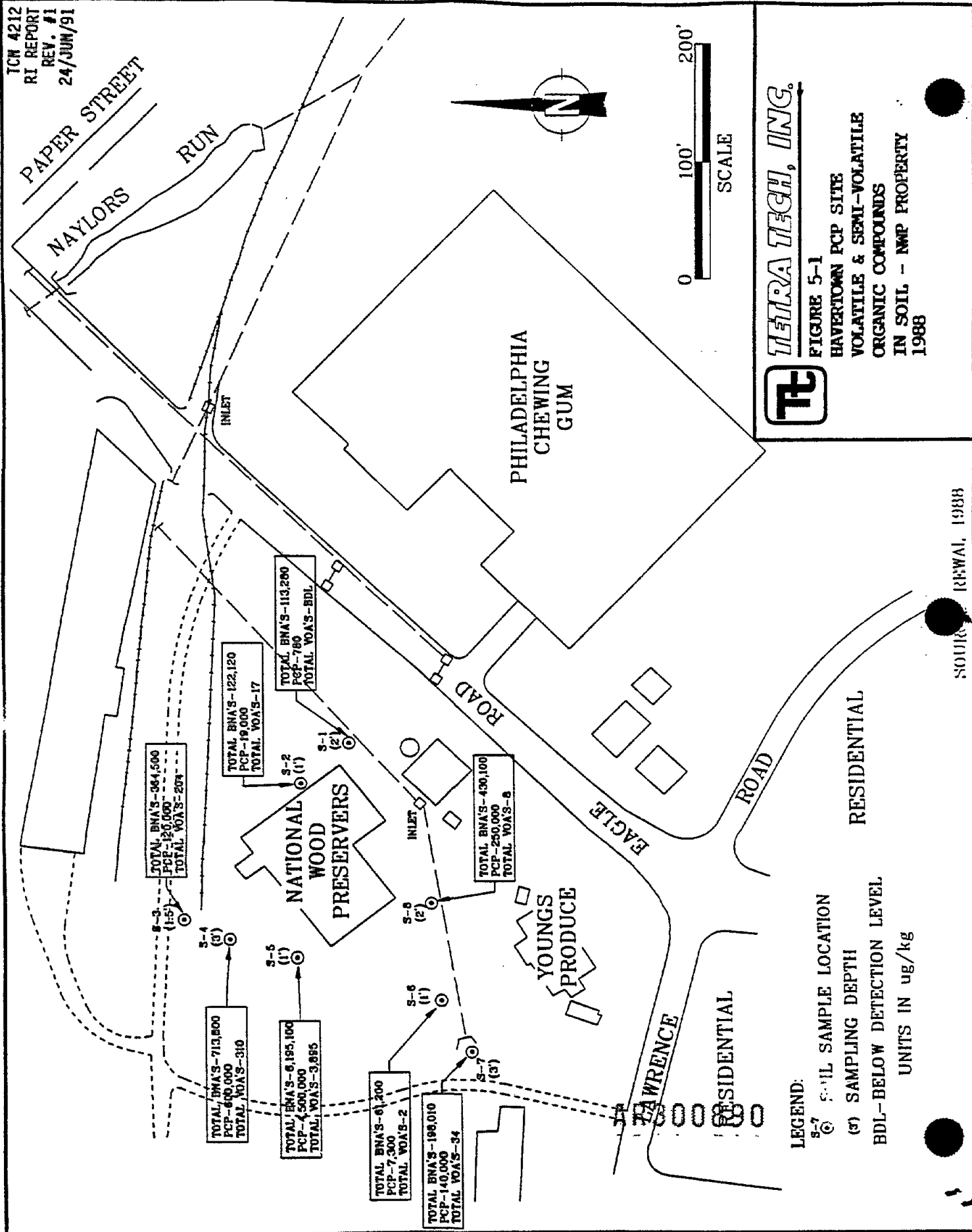
- ground-water migration;
- surface-water migration; and
- sediment migration.

Originally, contaminants (in waste oil) were introduced into the ground water via an injection well. Additionally, volatile and semi-volatile organic compounds in the surface soil on NWP property (Figure 5-1) are likely leaching from the soil into the ground water. Finally, contaminants have been directly introduced into Naylor's Run via surface soil erosion from NWP property.

With respect to ground-water migration, there are two elements to consider: free product contaminant (non aqueous phase liquid (NAPL)) migration and dissolved contaminant migration. The available data show contaminants in the ground water at the HAVERTOWN site are migrating throughout the shallow aquifer at the site, as well as into the fractured bedrock aquifer at the site and into the storm sewer which intersects the ground-water table in the area south of Philadelphia Chewing Gum Company. Contaminants in the ground water could also be migrating into Naylor's Run or other surface water courses at some point downgradient (southeasterly) of the site, as these are local and regional ground-water discharge points.

It should be noted that neither aquifer is currently being used for water supply in the vicinity of the site. According to local sources, Philadelphia Suburban Water Company and Haverford Township officials, there are no public or private water supply sources within 4 miles of the HAVERTOWN site (see Figure 2-3); the nearest public water supply well appears to be located in Valley Forge, PA, approximately 10 miles from the site. Consequently, there are no known migration pathways to water supply wells. However, the aquifers in this area are classified as Class IIB, indicating that the aquifers are a potential source of

AR300889



drinking water, capable of yielding a quantity of water sufficient for the needs of an average family (i.e. 150 gallons per day).

With respect to surface-water migration, the available data show low levels of contaminants migrating in the surface water (Naylors Run) at the site. Contaminants are introduced into the surface water through on-going surface runoff from NWP and other point and non-point sources (urban runoff), through direct discharge of contaminated ground water, through discharge of water (ground water) from the storm sewer, and through dissolution and release of contaminants from stream sediments. Most of the contaminants in surface water are in the dissolved phase, although previously the free product phase in the surface water was a frequent component. Contaminants entering the surface water at the site are predominantly migrating to downstream areas or are being sorbed to sediments.

With respect to sediment migration, the available data show contaminants are migrating with the sediments in Naylors Run at the site. Contaminants have been introduced into the sediments primarily as a result of past discharge of free product into Naylors Run, as well as from suspended sediments deposited from storm water runoff originating from contaminated surface soils at the site and discharge from contaminated ground water. The contaminants in the sediments are migrating to downstream areas primarily as a result of bedload and suspended sediment transport.

In addition to the above mentioned primary migration routes, one additional related route of migration, as a result of bioaccumulation, does exist. Given that some of the contaminants present at the site do bioaccumulate in fish and other aquatic life, movement of these fish and other aquatic life through surface water bodies will result in some migration of contaminants. Although only small amounts of contaminants are expected to migrate this way, bioaccumulation is an important fate process.

AR300891

5.2 CONTAMINANT PERSISTENCE

5.2.1 Ground Water

Most of the ground-water contaminants at the HAVERTOWN site are very persistent as a result of the continual source present (free product) and the residual amount of contaminant present in the subsurface throughout the site. Although the solubilities of many of the contaminants of special concern are low (e.g. pure PCP solubility in water is 14 mg/l at 20°C, and TCDD (dioxin) solubility is .0002 mg/l, PAH solubilities ranging from .001 to 32 mg/l), the source and residual contamination is of sufficient magnitude to allow large quantities of contaminants to remain in the ground water. Persistence of contaminants in the deeper aquifer is expected to be greater than in the shallow aquifer, as less biotransformation and sorbtion will occur in the deeper aquifer, resulting in less degradation and immobilization of contaminants. In general, contaminants will continue to be persistent in the shallow and deep aquifers as long as source areas, especially free product (NAPL) areas, exist in the subsurface.

5.2.2 Surface Water

Most of the contaminants found associated with the HAVERTOWN site are generally not persistent in the surface water at the site. This is true especially of the contaminants of special concern where, because of the relatively low solubilities, high soil adsorption coefficients (e.g. PCP Koc value of 5.3×10^5 , TCDD Koc value of 3.3×10^6 l/mg, and average PAH Koc values ranging from 10^4 to 10^5 (USEPA, 1989)), and numerous fate processes, the contaminants are found in relatively low concentrations at any given time in the surface water.

For example, with regard to the persistence of PCP in surface water, previous studies have shown that photolysis and microbial degradation are the predominant mechanisms degrading and transforming PCP in surface water (Pignatello and others, 1985). The half-life of PCP in surface water has been measured in the range of .15 to 15 days (Eisler, 1989). Degradation was determined to be most rapid under conditions of high incident radiation (i.e. abundant sunshine), high dissolved oxygen content, and elevated pH (Eisler, 1989). Given these

degradation processes, there is a relatively short residence time of PCP in aquatic environments (Nimmi and Cho, 1983) and total PCP destruction in the aquatic environment is likely (Wong and Crosby, 1978).

Given the short residence time of PCP in aquatic environments, the presence of PCP in the waters of Naylor's Run is indicative that there is an active source for the PCP. This source is likely the continuous discharge from the storm sewer.

With regard to dioxin, it was previously stated that these compounds are relatively insoluble in water, although it is slightly soluble in organic solvents and mixtures such as the PCP/oil mixture at the HAVER TOWN site. However, when present in water, it will decompose on exposure to sunlight (NIOSH, 1984). Therefore, the persistence of dioxin in the surface water is low.

5.2.3 Sediment

Most of the contaminants found associated with the HAVER TOWN site can be very persistent in the fine grained sediments of Naylor's Run. Given the low rate of exchange expected with surface water because of low solubility and high adsorption coefficients of the contaminants, the sediments act as a "contaminant sink" for some of the contaminants introduced into the surface water.

The persistence of PCP in the sediment, however, appears to be controlled primarily by microbial degradation, with sediment transport and photodegradation considered to be minor factors in the degradation process (DeLuane and others, 1983). Some studies have shown that the half-life of PCP in soils ranges from 10 to 40 days under anaerobic conditions, but under aerobic conditions, no degradation was observed after 60 days (Kaufman, 1978). Consequently, in areas where there are continuous sources, PCP will remain persistent; where the source has been removed or the source is limited, the PCP will degrade relatively rapidly in the sediments.

Given the low concentrations of PCP in sediments at the HAVER TOWN site, it is likely that the primary source of contamination for the sediments has been removed or is limited. The primary source of sediment contamination in the past

was likely free product flowing into Naylor's Run, or the result of suspended sediment transport of contaminants in surface runoff from the NWP site. Sorption of PCP to the sediments directly from surface water or from ground water discharge in the stream bottom are considered to be minor or negligible sources. As the amount of free product released into Naylor's Run has been reduced with the construction of an oil/water separator and other remedial measures, it appears as if the concentrations of PCP in the sediment have decreased, and will likely continue to decrease.

With regard to dioxin in sediments, although considered persistent in sediments, volatilization and photolysis are major removal processes (NRCC, 1981). Microbial degradation of most dioxins is considered slow (Ramel, 1978).

5.3 CONTAMINANT MIGRATION

Fate and transport processes affecting the migration of contaminants in the environment are summarized in Figure 5-2 (USEPA, 1989). A qualitative evaluation and analysis of these and other processes for each of the major migration pathways follows.

5.3.1 Ground-Water Transport

As stated previously, there are two elements to consider with respect to migration of ground-water: free product (non aqueous phase liquid (NAPL)) contaminant migration and dissolved product migration. Further within these elements, migration in the shallow and deep (bedrock) aquifers must also be evaluated.

With regard to the NAPL present at the site, available site information indicates that the NAPL at the site is likely a light non-aqueous phase liquid (LNAPL), rather than a dense non-aqueous phase liquid (DNAPL).

The primary evidence for the designation as a LNAPL is related to the makeup of the wood-treatment solution which was discharged into the ground. The primary wood-treatment solution in use at NWP from 1947 to 1978 was a five percent

Fate And Transport Processes Affecting Subsurface Migration

<u>Category</u>	<u>Process</u>	<u>Factor Affecting Process</u>
Physical	Advection Dispersion Flow in fractures Diffusion Precipitation Dissolution	Topography Climate Precipitation Soil type Vegetative cover Depth to ground water Soil permeability Soil void ratio Soil-moisture characteristics Geology Hydrology Morphology
Chemical	Partitioning -sorption/desorption -ion exchange -volatilization Equilibrium speciation -acid/base equilibration -organic complexation -inorganic complexation Abiotic transformation -hydrolysis -oxidation/reduction	Physical, chemical properties of contaminants Geology
Microbial	Oxidation/ reduction and hydrolysis	Geology Contaminants Microbial environment

AR300895



TETRA TECH, INC.

FIGURE 5-2
HAYVERTOWN PCP SITE
GENERAL FATE AND TRANSPORT
PROCESSES

solution PCP mixed with diesel fuel or mineral spirits (Todd, 1984). It is likely that during the early operation of NWP, PCP was purchased in block or flake form, heated, and mixed with the oil solution (Todd, 1984). PCP is a solid at standard atmospheric temperatures and pressures (and those found in the immediate subsurface), and consequently can not be a pure liquid under these conditions. Although the specific gravity of PCP is greater than 1, because the relative concentration of PCP in the mixture is low (5%), the specific gravity of the wood treatment solution was more similar to that of diesel fuel, which is less than 1. The specific gravity of the free product was determined to have a specific gravity of 0.897 (REWAI, 1988), which would make the mixture less dense than water, and characterize it as a LNAPL.

Concentrations of PCP detected in ground water at levels greater than the laboratory determined solubility (14 mg/l at 20° C.) in wells R2 (80 mg/l) and HAV 04 (63 mg/l), and relatively high concentrations detected in other wells (concentrations ranging from 1 to 4 mg/l) at first may seem indicative of the presence of a DNAPL. However, the presence of such high concentrations are not likely related to a DNAPL, rather, are a result of changes in the solubility of PCP in the presence of other chemical compounds.

The solubility of pure PCP in water and other solvents is summarized in Eisler (1989). The solubility of pure PCP varies from a low of 14 mg/l in water to a high of 650 g/l in methanol. The solubility of PCP in diesel fuel or mineral spirits is unknown, but is likely to be much greater than that of water. Therefore, the solubility of PCP in the ground water where there is (or was) free product present will be greater than the laboratory measured value of 14 mg/l, as a result of the presence of other chemical compounds. Consequently, the high concentrations of PCP can be explained by changes in solubility rather than the presence of a DNAPL.

Free Product Contaminant Transport

The future fate and transport of the oil mixture (free product), which is considered a light non-aqueous phase liquid (LNAPL), is difficult to predict. Given the LNAPL designation, previous or future fate and transport of the free

product in the deeper aquifer is not considered likely. However, historical data indicate that the LNAPL was previously present in the shallow aquifer over a larger area than it is at present. Further, an increase in dissolved contaminant concentrations is related to the apparent transition from free product phase to dissolved phase over time. Consequently, it follows that the degree of LNAPL saturation in the subsurface has decreased substantially, and is possibly approaching a level of residual saturation, i.e. approaching a level at which the LNAPL no longer exists as a separate liquid.

According to Palmer and Johnson (1989), at residual NAPL saturation, the relative permeability of the NAPL is zero, and the NAPL is considered to be immobile. Since the NAPL is no longer moving, the contaminants can only be removed from the pores of the subsurface through dissolution as ground water flows through the shallow aquifer system. This is possibly why a pilot oil recovery test, performed in 1989, resulted in collection of only 56 gallons of free product. Given the likely situation at the HAVERTOWN site of a large area of residual NAPL saturation, slow ground-water flow velocities, and generally low solubility of semi-volatiles, the process of dissolution of the residual NAPL will be very lengthy.

Although some free product remains in the subsurface, it is not likely to migrate as a LNAPL beyond the general area presently delineated. However, as the LNAPL continues to undergo dissolution, the potential exists that dissolved contaminant compounds could migrate beyond currently delineated plume boundaries.

Dissolved Contaminant Transport

An evaluation of historical data reveals that the location of plume of ground-water contamination appears to have been relatively constant over the last three years (1988-1991). Given the length of time the contaminants have been present in the ground water, it is presumed that the plume may have existed under relatively steady-state conditions during the last three years. Steady-state conditions would imply that the combined physical, chemical, and microbial processes (Figure 5-3) acting on the contaminants prevent their further migration beyond the current plume boundaries. Dilution, sorption, transformation

AN 100007

Reference: Wilson and Miller (1978)

Objective: To determine contaminant concentration for a given time and location from a continuously discharging, fully penetrating line source. Contaminant transport is dominated by the regional flow.

Assumptions:

- uniform, steady regional flow in the x direction
- contaminant enters the aquifer over the full saturated thickness of the aquifer at $x = 0, y = 0$
- linear, equilibrium adsorption of the contaminant
- decay of the contaminant in the aquifer is first-order
- mass loading rate of contaminant is continuous and constant over the time period of interest

$$c(x,y,t) = \frac{c_o Q}{4\pi p b (D_x D_y)^{1/2}} \exp\left(\frac{v_x x}{2D_x}\right) W\left(u, \frac{r}{B}\right)$$

where

$W(\cdot)$ = the leaky well function of Hantush

$B = 2D_x/v_x$ (m)

$r = \left(\alpha \left(x^2 + y^2 \frac{D_x}{D_y} \right) \right)^{1/2}$ (m)

$u = \frac{r^2 R_d}{4\alpha D_x t}$ (unitless)

$\alpha = 1 + 2BR_d k/v_x$ (unitless)

Q = volumetric rate of discharge of the line source (m^3/day)

t = time (days)

(x,y) = spatial coordinates (m)

D_x, D_y = dispersion coefficients (m^2/day)

v_x = seepage velocity of the regional flow (m/day)

p = porosity of the aquifer (unitless)

b = saturated thickness of the aquifer (m)

k = total decay rate constant for the contaminant (1/day)

R_d = retardation coefficient for linear adsorption (unitless)

c_o = concentration of contaminant being discharged (mg/l)



TETRA TECH, INC.

AR300898

FIGURE 5-3
HAVERTOWN PCP SITE
TWO-DIMENSIONAL FLOW WITH
CONTINUOUS SOLUTE SOURCES
ANALYTICAL SOLUTION SUMMARY

biodegradation, and other factors are presumably reducing concentrations at present to below quantitation or detection levels at the furthest downgradient shallow sampling location (HAV-07), and at other likely downgradient areas located to the east of well cluster 6 and HAV 08.

For example, simple calculations of contaminant transport strictly as a result of advection (contaminants moving solely at a rate equivalent to ground-water flow velocity) indicate that historically, contaminants should have reached the furthest downgradient location long ago. Assuming that contamination was first introduced in the late 1940's, and an average advection transport rate of 85 feet per year, the contaminants could have traveled over 3400 feet over the last 40 years. However, the data show that at downgradient location (HAV-07) situated approximately 800 feet east of the major source area has not been substantially impacted, although recent water quality data (November 1990) indicate the low level presence of two volatile compounds and PCP, but at quantities that could not be accurately or precisely calculated.

It should be noted that the presence of the storm sewer in the downgradient location is also a factor affecting the fate and transport of ground-water contaminants. Television inspection of the storm sewer indicates the numerous points of inflow of ground water into the sewer; "oil" residuals were also observed in the sewer. This would indicate that the storm sewer may be acting as a "ground-water sink or interceptor." The presence of such a sink or interceptor could act to retard contaminant migration to areas further downgradient.

Despite the apparent processes affecting fate and transport of ground-water contaminants, and the appearance of "steady-state" conditions, overall concentrations of ground-water contaminants have increased since 1988, indicating that the system is not under steady-state conditions. As stated previously, this is likely the result of the further dissolution of free product in the subsurface. Assuming the natural system capabilities for diluting, sorbing, transforming, and biodegrading the contaminants are constant per unit volume of aquifer, an increase in concentration (mass) of dissolved contaminants will

AR300899

likely result in the further migration of contaminants in the downgradient direction.

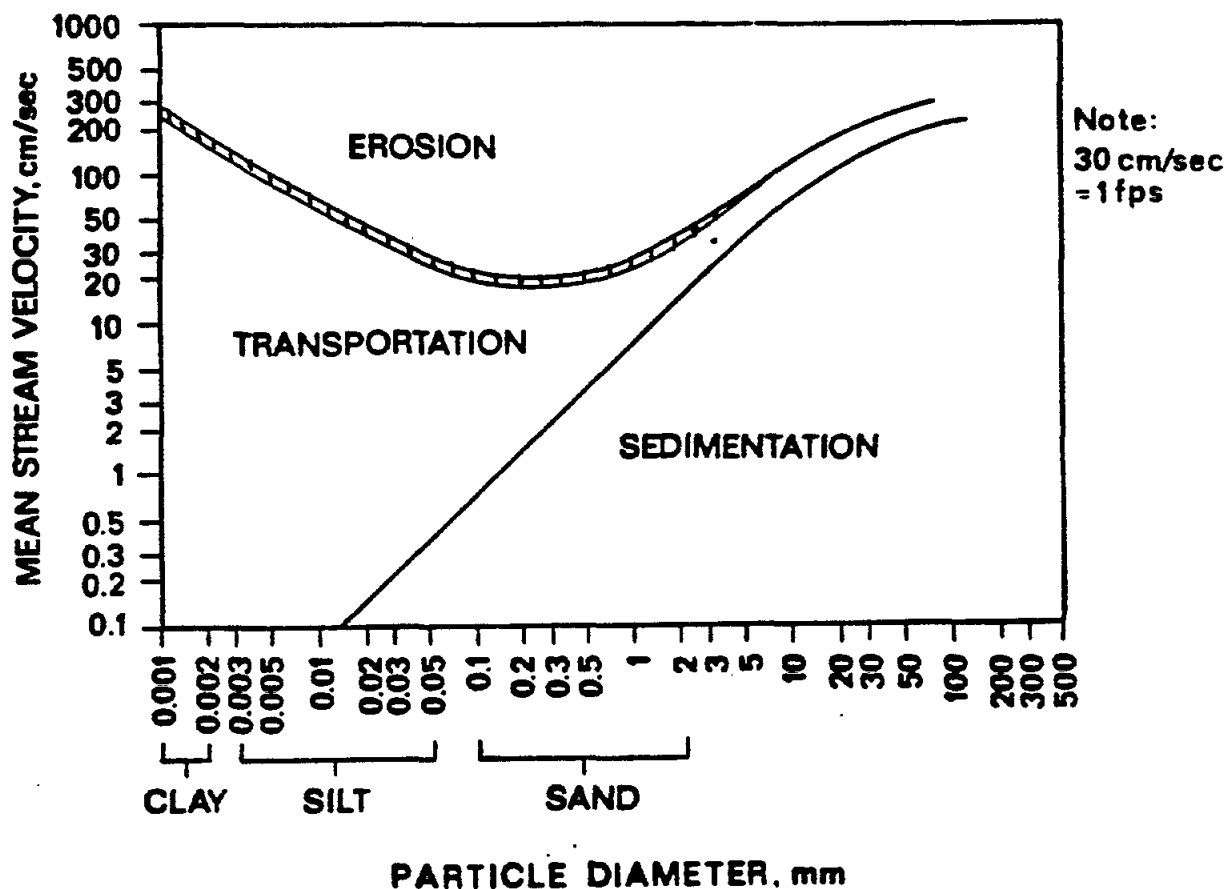
The extent of further migration in the downgradient direction is difficult to quantify without complex numerical methods. However, given the observation that major ground-water contaminants are generally diluted, sorbed, transformed, or degraded to concentrations below limits of analytical quantitation at sampling points within 800 to 1000 feet downgradient of the original source area, further downgradient migration of contaminants will not likely be substantial.

Using a simple analytical solution for two-dimensional horizontal flow with continuous sources developed by Wilson and Miller (1978) (see Figure 5-4), an estimate of the extent of further migration in the shallow aquifer can be calculated. A general analytical algorithm package called ENVSIM (Tetra Tech, 1986), which includes the Wilson and Miller solution was used for the calculation. ENVSIM is a microcomputer program for calculating toxicant transport in ground waters and rivers based on the solutions provided in the water quality assessment screening procedures document prepared by Mills and others (1983).

For the purposes of evaluating further migration, a scenario of contaminant transport beyond location HAV-07 (furthest downgradient sampling station) will be assessed. Given the following assumptions:

- maximum future concentration of PCP at HAV-07 of 1 mg/l
- saturated thickness of aquifer - 12 feet
- seepage velocity - .23 feet per day
- porosity of aquifer - 21 percent
- no retardation or decay (i.e. change in concentration by advection, dispersion and dilution only)

Given these assumptions, the calculated maximum concentration of PCP in ground water at a sampling point located approximately 300 feet downgradient of HAV-07 is estimated to be 120 ug/l. Should retardation (as a result of sorption) or contaminant decay (as a result of transformation or biodegradation) be included



TETRA TECH, INC.

AR300801

FIGURE 5-4
HAVERTOWN PCP SITE
RELATIONSHIP BETWEEN STREAM
VELOCITY, PARTICLE SIZE, AND
REGIMES OF EROSION, TRANSPORT
AND DEPOSITION

in the solution, the concentration would be substantially reduced. For example, using a retardation coefficients of 10 and 100, the calculated maximum concentrations of PCP at the sampling point would be estimated to be 80 ug/l and 15 ug/l, respectively. Adding a decay term to the calculation would lower these numbers even further. Therefore it is concluded that further migration in the shallow aquifer downgradient of HAV-07 will not likely be substantial.

The extent of further migration of contaminants in the bedrock aquifer at the site is more difficult to assess. Fate and transport of contaminants in this aquifer is further complicated by the complexities and uncertainties of ground-water flow through fractured bedrock. In general, available site data indicate that contaminants are likely migrating from the shallow aquifer into the deeper aquifer in the vicinity of NWP. Vertical ground-water gradients measured at cluster well location 1 near NWP indicate a downward flow component, whereas in other areas of the site closer to Naylor's Run, the vertical gradient appears to be upward.

Sorption, transformation and biodegradation play a less important role in affecting the fate and transport of contaminants in the bedrock aquifer. In general, the bedrock aquifer has limited organic material for sorption, and limited biological activity is occurring as a result of the anaerobic conditions. Therefore, advection and diffusion are the primary processes in the bedrock aquifer.

Ground-water contaminants will continue to migrate through the bedrock aquifer as long as a source area remains in the bedrock aquifer recharge area (especially in the vicinity of NWP). The ground-water gradient in the bedrock aquifer is similar to that of the shallow aquifer (approximately .024 ft/ft), however, given the more circuitous ground-water travel routes likely in the bedrock as a result of fracture orientation, the relative ground-water velocities in the bedrock aquifer are expected to be less than those in the shallow aquifer. Using very conservative estimates for bulk hydraulic conductivity in the fractured rock (3×10^{-9} ft/s), and bulk porosity in the fractured rock (10^{-4}) (Freeze and Cherry, 1979), the average linear ground-water velocity is estimated to be 2063 ft/day (which is equivalent to nearly 25 feet per year) in the bedrock aquifer.

Therefore time of transport to discharge areas, which is predominantly the shallow aquifer (where present) or surface water streams (Naylors Run, Cobbs Creek), will be lengthy at this slow relative average velocity. Using this velocity value and assuming that contamination was first introduced into the bedrock aquifer over 40 years ago, ground-water contamination in the bedrock aquifer may have migrated to areas over 1000 feet downgradient of the site of introduction at NWP.

5.3.2 Surface-Water Transport

Contaminant migration via surface-water transport, in addition to those parameters listed in Figure 5-2, is a function of the concentration present in the water, the surface water chemistry, discharge characteristics (flow) in the stream, and other physical and chemical factors.

The predominant process controlling the fate of organic contaminants (primarily PCP) in the surface water are simple diffusion and dilution. Photolysis and biodegradation also appear to be important fate processes for PCP in the aquatic environment (Callahan and others, 1979). The predominant processes controlling the fate of inorganics are also simple diffusion and dilution also, although precipitation and sorption processes are also important.

The extent of diffusion and dilution in Naylors Run can be demonstrated with an analysis of stream flow and concentration data. Using the general concentrations of organic contaminants present at location NAY-08 (140 ug/liter total semi-volatiles (primarily PCP), and the average stream discharge rate measured at NAY-08 (0.02 cubic meters/second), approximately .242 kilograms of total semi-volatile compounds (primarily PCP) would be migrating through the surface water through NAY-08 each average day. This is equal to approximately 88 kilograms per year being transported via surface water at the flow discharge measured, although it should be noted that the amount of contaminant discharge would likely be higher during transient periods of high flow.

Assuming that all of the surface water contamination present is entering the surface water in areas upstream of NAY-08, contaminants are being primarily

diluted with the increased flow and further degraded with time downstream of NAY-08. For example, with respect to total semi-volatiles, and assuming a contaminant loading of 2800 ug per second through NAY-08 (140 ug/l concentration x 20 liters/sec flow rate), the expected concentration at station NAY-10, with a flow rate of approximately 360 liters/sec, is calculated to be approximately 7 ug/l (assuming no other degradation or removal). At the confluence with Cobbs Creek, with a flow rate of approximately 950 liters/sec, the total semi-volatile concentration is calculated to be approximately 3 ug/l.

With respect to inorganics and dioxin, surface-water transport of these contaminants is not considered to be substantial. Inorganics are not present in high concentrations in surface water and no dioxin was detected in any surface water samples collected from Naylor's Run, although small amounts were detected in the sample collected from the catch basin. However, given the extremely low solubility of dioxin in water, extensive transport in surface water is considered unlikely.

Limited contaminant transport via surface water will continue as long as contaminated sediment (source) continues to be present, and contaminated ground water or contaminated surface runoff from the site continues to discharge into Naylor's Run.

5.3.3 Sediment Transport

Contaminant migration via sediment transport is a function of the type, extent, and nature of contaminants, physical and chemical characteristics of the sediment, the configuration of the stream, and the characteristics of stream flow.

With respect to the physical and chemical characteristics of the sediment, the sediment in Naylor's Run is predominantly coarse in nature. Grain size analysis indicate a generally coarse to fine sand texture, with the median D_{50} (mm) ranging from 3.6 mm at NAY-01 to 0.41 mm at NAY-10. Additionally, the general total organic carbon (TOC) content of the sediment is generally low (3.3 to 8.850 mg/kg). Consequently, the contaminants detected in the sediment are likely

"coating" the sand grains in the sediment, although some sorption of the contaminants directly to the organic portion of the sediment is also likely occurring. Therefore, the contaminants are predominantly migrating with the sediment as part of bedload movement, or are being removed from the sediment to the surface water via abrasion (or other physical removal), or dissolution, or desorption directly to surface water from the individual sediments. It should be noted that contaminant transport via bioturbation, which is the mixing of sediments by organisms, is not considered to be important at the site. However, contaminant transport resulting from the movement of aquatic life that have bioaccumulated contaminants is important at the site.

In general, sediment (bedload and suspended) transport (and subsequent contaminant transport) will vary along different sections of Naylor's Run. Sediment transport will naturally be higher in areas with the highest velocity and turbulence, where shear stresses sufficient to move the sediment are produced.

With respect to the evaluation of contaminant migration, it is important to determine if contaminant migration via sediment transport is predominantly occurring continuously or only during periods of high flow (storm events). Given average estimated flow velocities in Naylor's Run of 0.03 m/sec (3 cm/sec), average grain sizes of 0.68 mm, and a simple application of a Hjulstrom type diagram (Mills and others, 1983) (Figure 5-4), it appears that most of the sediment bedload is not moving under average flow conditions, and any suspended sediment is being deposited.

Given the above analysis, contaminant migration in the sediment is predominantly occurring via sediment (bedload and suspended) transport during high flow periods, although there is some migration to the surface water under normal conditions via physical removal or dissolution from the sediment. This migration will continue to occur along the entire stretch of Naylor's Run, although sediment dilution and further degradation will result in lower concentrations of contaminants in sediments downstream with time. Migration will continue as long as contaminants remain in the sediment.

AR300905

6.0 BASELINE RISK ASSESSMENT

SUBMITTED UNDER SEPARATE COVER

AR300906

7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The HAVERTOWN PCP site covers approximately 12 to 15 acres of land in Haverford Township, Delaware County, Pennsylvania. The site consists of several commercial properties including National Wood Preservers, Young's Produce, Swiss Farms, and Philadelphia Chewing Gum, and a residential area located on the north side of Rittenhouse Circle. Naylor's Run, a small stream running through the residential area, is also considered part of the site.

Contaminants present in the ground water, surface water, sediments, and soils of the HAVERTOWN PCP site originate from the National Wood Preservers (NWP) property. Since 1947, NWP has preserved wood using various chemicals including pentachlorophenol in a petroleum solvent, fluoro chrome arsenate phenol, and chromated copper arsenate. Reportedly, from 1947 to 1963, waste products and spent solvents were disposed of in an injection well located on the site presently occupied by Young's Produce.

7.1.1 NATURE AND EXTENT OF CONTAMINATION

The present nature and extent of contamination on the HAVERTOWN PCP site is summarized for ground water, surface water and sediments in Naylor's Run, and water and sediment collected from several portions of the storm sewer feeding into Naylor's Run.

Ground Water - Volatile organic compounds (VOCs), semi-volatile organic compounds (predominantly pentachlorophenol), and dioxin isomers are the majority of the contaminants present in the ground water on the HAVERTOWN site.

The volatile organic compounds trichloroethene and 1,2-dichloroethene are found in highest concentrations (630 and 270 ug/l, respectively) on the National Wood Preservers property and decrease from west to east across the site. Other prevalent VOCs, benzene and total xylenes, are found in highest concentration on Philadelphia Chewing Gum property (270 and 1700 ug/l, respectively). In general, AR300907

the concentration of all volatile organic compounds has decreased in most monitoring well locations since 1988. One exception is at well CW-6D, which is the furthest downgradient monitoring point in the deep hydrologic zone. There has been little change in the concentration of VOCs in this well since 1988.

Semi-volatile organic compounds have generally increased in concentration since 1988. Pentachlorophenol and polycyclic aromatic hydrocarbons (PAHs) make up the majority of the semi-volatile organic compounds present in the ground water. Highest levels of PCP were present in wells R-2, HAV-04, and HAV-02 (80000, 63000, and 1900 ug/l, respectively). Wells R-2 and HAV-02 presently contain floating free petroleum product. Well HAV-04 contained free product in the past. The increase in PCP concentration may be related to a decrease in the thickness of free product observed in the shallow hydrologic zone since 1988, suggesting dissolution of the free product into the ground water. PCP was found for the first time in the furthest downgradient shallow well, HAV-07. PCP is also present in the deep hydrologic zone, although generally in lower concentrations than those observed for the shallow hydrologic zone.

There are numerous dioxin isomers, all of which vary in their potential toxicity. The isomer 2,3,7,8 TCDD is considered to be the most toxic of the isomers. To evaluate dioxin, concentrations of all isomers are converted to a toxicity equivalent for 2,3,7,8 TCDD. Although 2,3,7,8 TCDD was only present in 1 monitoring well, almost all monitoring points exceeded a 2,3,7,8 TCDD toxicity equivalent of zero. The 2,3,7,8 TCDD toxicity equivalent of the ground water has apparently increased dramatically since 1988, especially in wells that still contain free floating product.

Naylor's Run and Cobbs Creek - The surface water contained predominantly VOCs and PCP. Minor concentrations of pesticides and metals were also present. The surface water was generally absent of other semi-volatile organic compounds (besides PCP) and contained no dioxins. VOCs and PCP are not the dominant contaminants in the sediments. Instead, the PAH subgroup of semi-volatile organic compounds dominate.

AR300908

As with ground water, the primary VOCs in the surface water were benzene, total xylenes, trichloroethene, as well as toluene and ethylbenzene. All VOCs decreased in concentration downstream. No VOCs were present in the furthest downstream location in Naylors Run (NAY-01). The total VOC concentration was 205 ug/l, immediately outside the catch basin.

The concentration of PCP in the surface water ranged from a maximum of 1200 ug/l, in water entering the catch basin (NAY-03), to 3 ug/l at the furthest downstream location sampled, Cobbs Creek station 01. The maximum concentration of PCP and PAHs in the sediment were found at station 06 in concentrations of 3000 (J) and 111,200 ug/kg, respectively. No PCP was found in the sediment downstream of station 08 (above quantitation limits of 1000 ug/kg).

The pesticides gamma-BHC, 4,4'-DDD, heptachlor epoxide, and dieldrin were present in the surface water. At least one of these pesticides was present at every surface water station but no more than 2 pesticides were detected at any 1 station. The maximum concentration of any pesticide was 0.77 ug/l. Dieldrin, beta-BHC, heptachlor, aldrin, 4,4'-DDD, endosulfan sulfate, and endrin were all present in the sediment. Heptachlor represented the pesticide found in the highest concentration in the sediment at 160 ug/kg.

Aluminum, cobalt, lead, manganese, and thallium represented the metals of concern in the surface water. These metals, plus antimony, arsenic, barium, chromium, and vanadium were prevalent in the sediments. Only antimony, lead, and thallium were not found at every sample station.

All surface water samples located away from the immediate vicinity of the catch basin had a 2,3,7,8 TCDD toxicity equivalent of zero. All sediment samples collected in Naylors Run did contain dioxin isomers, although in low concentrations outside the immediate vicinity of the catch basin.

Storm Sewer - Volatile organic compounds, PCP and dioxin were found in a water sample collected from station 02A. The TV inspection of the storm sewer indicated numerous points of ground water inflow and what appeared to be oil stains at pipe joints. The presence and concentration of these compounds,

mentioned above, reflect the ground water contribution to the water in the storm sewer.

A sediment sample collected from the drainage swale located adjacent to NWP indicated the presence of PCP in a concentration of 20,000 ug/kg. The location of this sample supports the assertion that some of the sediment contamination in Naylors Run is a direct result of surface soil erosion from NWP.

Comparison with 1988 Data

A comparison of results obtained in 1988 (REWAI, 1988) to those obtained in this investigation is summarized in Table 7-1.

7.1.2 FATE AND TRANSPORT

Several contaminant migration pathways have been documented in this investigation. Contaminants were previously directly introduced into the ground water through an injection well. Evidence suggests that contaminated surface soil has been eroded from NWP and transported to Naylors Run via the storm sewer. Once contaminants have entered Naylors Run, they may be transported in the surface water, sediments, or through bioaccumulation processes. Additionally, contaminants are very likely being leached into the ground water from contaminated soil on NWP property.

Ground Water Pathway - In evaluating the contaminant fate and transport in the ground water at the HAVERTOWN site, flow conditions in two hydrologic zones must be considered. Additionally transport of free product versus transport of dissolved contaminants must be considered.

Ground water from the shallow hydrologic zone is discharging into the reach of Naylors Run below the catch basin. The calculated flow velocity in the shallow hydrologic zone is approximately 85 feet per year. Based on the length of time NWP has been in operation, contaminants in the shallow hydrologic zone could have migrated approximately 3400 feet in the last 40 years. However, this investigation indicates that PCP has just reached well HAV-07, located only 800

TABLE 7-1
HAVERTOWN PCP SITE
COMPARISON OF RESULTS
1988 VS 1990-1991^a

<u>Medium</u>	<u>Comments</u>
Groundwater	<ul style="list-style-type: none"> ● PCP was not present in furthest downgradient shallow well (HAV-07) in 1988 but was detected there in 1990. ● Free product thicknesses have decreased since 1988. ● Dissolved PCP concentrations have increased since 1988. (May be related to decrease in free product thickness). ● Concentration of volatile organic compounds has decreased in many well locations since 1988. ● The concentration of dioxin isomers has increased dramatically since 1988.
Surface Water	<ul style="list-style-type: none"> ● The surface water contains primarily VOCs and PCP. Concentrations of these compounds have not shown a significant change since 1988. ● No dioxins were present in the surface water in 1990 but they were present in 1988.
Sediment	<ul style="list-style-type: none"> ● There appears to be little change in the concentration of PCP in the sediment from 1988 to 1990.

^a Data for 1988 from REWAL, 1988
Data for 1990 from this investigation

AR300911

feet from NWP. It is believed that the storm sewer behind the PCG building is intercepting some shallow ground water and acting as a conduit for transport of ground water into Naylor's Run. Factors such as dilution, biodegradation, and transformation could also be inhibiting further migration of contaminants in the ground water.

Ground water flows downward from the shallow hydrologic zone to the deep hydrologic zone on NWP but has an upward direction of flow in wells on PCG property. The deep hydrologic zone is therefore probably providing some recharge to the shallow hydrologic zone in the vicinity of Naylor's Run. Some portion of the ground water in the deep hydrologic zone likely travels under Naylor's Run and discharges further downgradient (to the southeast). Ground water flow velocity in the deep hydrologic zone, within fractured bedrock, is estimated to be 25 feet per year. With no degradation, sorption, transformation, etc., dissolved contaminants could be presently be 1000 feet downgradient of NWP.

Free petroleum product was observed in wells R-2 and HAV-02. The product is considered a Light Non-Aqueous Phase Liquid (LNAPL). The lateral extent of the free product plume has apparently decreased with time. Because the LNAPL is by definition less dense than water, it will not directly affect the deep hydrologic zone. The decrease in lateral extent and thickness of free product may however, be associated with a recent increase in the concentration of PCP in the shallow hydrologic zone.

Surface Water Runoff Pathway - Ground water is not providing any base flow to the reach of Naylor's Run above the catch basin. Contaminants that are found in this section of Naylor's Run have likely travelled in surface water runoff from NWP property. A comparison of contaminants in the surface soil on NWP and contaminants found in the sediments of Naylor's Run (see Table 6-49) indicates many of the contaminants found in the soil are present in the sediment. Additionally, the presence of PCP in a concentration of 20,000 ug/kg and dioxin isomers, with a 2,3,7,8 TCDD toxicity equivalent of 20.8 ppb, in the drainage swale adjacent to NWP which drains directly to Naylor's Run provides additional evidence for the viability of this pathway.

AR300912

Transport in Naylor's Run - The flow characteristics of Naylor's Run, combined with grain size data indicate that the sediment is probably transported in a bedload regime only during high flow storm events. Dilution, diffusion, photolysis, and biodegradation may act on contaminants dissolved in the surface water. However, a close match between the predicted and observed downstream decrease in PCP concentrations can be accounted for by dilution alone. Bioaccumulation of contaminants may also play a role in transport of contaminants in Naylor's Run; however, its role is difficult to quantify.

Contaminant Leaching from Subsurface Soils - This pathway was not investigated as part of this RI. However, given the concentrations of PCP and other contaminants in the surface soil (see Figure 5-1), it is expected that the subsurface soils of NWP are also contaminated. These soils could be expected to leach contaminants into the shallow hydrologic zone.

7.1.3 RISK ASSESSMENT

Human Health - The total carcinogenic risk to children playing in Naylor's Run is 9×10^{-7} from dermal absorption of chemicals of potential concern in surface water and 1×10^{-4} from dermal absorption and ingestion of chemicals of potential concern in sediment in Naylor's Run. The estimated carcinogenic risk to children for contact with, or ingestion of sediments is above the NCP point of departure and equal to the upper bound of the NCP acceptable risk range. The majority of the risk was associated with benzo (a) pyrene (Equivalent). The noncarcinogenic risk associated with these media have hazard quotients less than 1, indicating that noncarcinogenic effects will probably not be observed.

The total carcinogenic risk associated with ingestion of fish tissue (from Cobbs Creek) is 2×10^{-3} and is associated with dieldrin. It is uncertain whether dieldrin is derived from the HAVERTOWN PCP site or derived from other sources. The carcinogenic risk associated with 2,3,7,8-TCDD (Equivalent) exposure for nursing infants, whose mothers ingest fish tissue, is 1×10^{-4} . A noncarcinogenic risk may also result from ingestion of fish due to the presence of dieldrin, heptachlor epoxide, and dioxin.

AR300913

The total carcinogenic risk associated with exposure to all pathways under current land use is 2×10^{-3} while the hazard quotient exceeded unity (1) by a factor of 50.

There are currently no users of ground water in the vicinity of the HAVERTOWN site. However, the carcinogenic risk associated with ingestion of ground water with current concentrations of PCP, 2,3,7,8-TCDD (Equivalent), and PAHs is nearly 0.5, or one half a million times above the NCP point of departure. The noncarcinogenic risk, associated mainly with dioxin, exceeded unity by a factor of 5,000.

In summary, there are high carcinogenic and noncarcinogenic risks associated with the use of ground water due to polycyclic aromatic hydrocarbons, PCP, and dioxin contamination. The extent of primary contamination of these chemicals appears to be sufficiently characterized by data from existing monitoring wells.

Carcinogenic polycyclic aromatic hydrocarbons in sediments may present a potential human health impact from direct contact. Pesticides and dioxin in surface water and sediments may contribute to the health risk associated with ingestion of fish (from further downstream) and subsequent indirect exposure to nursing infants. It is uncertain whether the chemicals present in the fish tissue are associated with chemical releases from the site.

Ecology - The benthic macroinvertebrate community is impaired due to the presence of semi-volatile organic compounds, along with the minor contribution of pesticides, aluminum, iron, lead, manganese, and dioxin in Naylor's Run. Low EPT abundance, low diversity, poor community structure, and low number of organisms support this conclusion.

It was observed that the benthic community improves with distance downstream from the Havertown PCP Site. Additionally, it should be noted that the benthic community within Naylor's Run and Cobbs Creek has improved compared to historic studies. Further characterization as to the point sources of the contamination in Naylor's Run is needed. Channelization and receipt of urban storm water runoff

AR300914

is a continual source of stress to Naylor's Run that will limit Naylor's Run from becoming a high quality aquatic community.

Additionally, terrestrial birds and waterfowl may be exposed to levels of contaminants in the water and sediment that could cause chronic toxicity. However, the toxic levels are only present in the upper reach of Naylor's Run, located closest to NWP. The terrestrial vegetation appears to be typical of stream bank vegetation found in the area.

7.2 CONCLUSIONS

7.2.1 DATA LIMITATIONS AND RECOMMENDATIONS FOR ADDITIONAL WORK

In 1989, the USEPA issued a Record of Decision (USEPA, 1989b) for the HAVERTOWN PCP site, which addressed on-site soils, staged waste materials, and storm sewer effluent at the catch basin in Naylor's Run. The "selected remedy for the on-site soils is the "No Action" alternative. This alternative achieves remedial action objectives because the potential threat to the public's health associated with the continued entrainment of contaminated dust and infiltration of contaminants into the environment poses no significant risk." The ROD called for the construction of an oil/water separator at the outfall of the storm sewer to reduce the concentrations of oil, PCP, and volatile organic compounds entering Naylor's Run.

The ROD outlined a future operable unit. This operable unit would involve the further investigation of the ground water and the sediments in Naylor's Run. This remedial investigation was designed to address these two media. More specifically, focus has been placed on determining the potential human health and environmental risk associated with these two media. This task has been performed.

The data collected during this remedial investigation are largely limited to use in risk assessment. Data that would need to be collected, or additional studies that are recommended prior to implementation of any selected remedial alternatives include:

AR300915

Ground Water - Further investigation of the lateral and vertical extent of contamination in the deep hydrologic zone is necessary. Tetra Tech recommends installation of at least two monitoring wells, screened or open to the fractured bedrock on the north side of Naylor's Run, downgradient of cluster well group 6.

Naylor's Run Sediments - This investigation has shown that contaminated sediments in Naylor's Run could have originated from NWP, via erosion and transport of contaminated surface soils through the storm sewer. It is unknown however, whether this process is ongoing or whether the contaminants observed in the sediments are due to historical events. Additionally, some contaminants in the sediments, pesticides and PAHs, may be derived from point sources other than NWP. Further sampling of surface soils between NWP and Naylor's Run, along with collection of background samples is recommended.

Subsurface Soils - More information on the extent of contamination in the subsurface soils of NWP is required to determine the full impact of contaminants leaching from the subsurface soils into the ground water. A series of borings on and immediately adjacent to NWP is recommended.

7.2.2 RECOMMENDED REMEDIAL ACTION OBJECTIVES

Because two different media were investigated, ground water and sediments, the remedial action objectives are broken down into 2 classes.

Ground-Water - The remedial action objective for the ground water is to restore the shallow and deep hydrologic zones to meet ARARs for semi-volatile organic compounds and dioxin compounds and thereby prevent exposure to carcinogenic and noncarcinogenic compounds in the water.

In order to meet this objective, the recommended course of action would call for remediation of the shallow hydrologic zone, prior to remediation of the deep hydrologic zone. This is recommended because the shallow hydrologic zone recharges the deep hydrologic zone on NWP and attempted remediation of the deep hydrologic zone (prior to remediation of the shallow zone) may induce further

AR300916

contamination into the deep hydrologic zone. Means that could be employed to meet this objective include:

- Removing remaining free product from the subsurface in order to inhibit further degradation of the ground water in the shallow hydrologic zone.
- Controlling the discharge of contaminated ground water from the shallow hydrologic zone into Naylor's Run.
- After remediation of the shallow hydrologic zone is completed, containment or capture of contaminated ground water in the deep hydrologic zone should be evaluated.

Naylor's Run Sediment - The remedial action objective for sediment in Naylor's Run is to remediate the sediments such that further contamination of other media linked to sediment (surface water and ground water) will not occur and such that the risk associated with exposure to contaminated sediments is reduced to an acceptable level.

The means to achieve this objective include containment or removal.

Screening and evaluation of specific remedial alternatives to meet these objectives will be addressed further in the Feasibility Study which will be submitted under separate cover.

AR300917

8.0 REFERENCES

- Berg, T.M., and Dodge, C.M., 1981, Preliminary Geologic Map of the Landsdowne Quadrangle, PA; in Atlas of Preliminary Geologic Quadrangle Maps of PA, Pennsylvania Geologic Survey, 4th series.
- Callahan, M.A, and others, 1979, Water-Related Environmental Fate of 129 Priority Pollutants, Volumes 1 and 2, EPA-440/4-79-029a, prepared by USEPA Office of Water Planning and Standards and Office of Water and Waste Management, December 1979.
- Coyne, D., and Sheaffer, K. K., 1975, Aquatic Biology Investigation; Bioassay of Naylor's Run, Delaware County, Haverford Township, PADER, Rep. 1.14.0.
- DeLaune, R.D., Gambrell, R.P., and Reddy, K.S., 1983, Fate of Pentachlorophenol in estuarine sediment, Environmental Pollution, 6B:297-308.
- Eisler, R. 1989., Pentachlorophenol hazards to fish, wildlife, and invertebrates: a synoptic review., U. S. Fish and Wildlife Serv. Biol., Rep. 85 (1.17), 72 pp.
- Federal Interagency Committee for Wetland Delineation, 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. U. S. Army Corps of Engineers, U. S. Environmental Protection Agency, U. S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service. Washington, D.C. Cooperative Technical Publication. 26 pp., plus appendices.
- Freeze, R.A., and Cherry, J.A., 1979. Groundwater, Prentice-Hall, 604 p., Golstein, Allen, May 31, 1991, personal communication.
- Hilsenhoff, W. L., 1982. Using a Biotic Index to Evaluate Water Quality in Streams, Technical Bulletin No. 132, Department of Natural Resources, Madison, Wisconsin.

AR300918

Humphreville, J. A., 1982. Groundwater Contour Map and Oil Thickness Isopach Map.

Kaufman, D.D., 1978, Degradation of pentachlorophenol in soil, and by soil microorganisms, in Pentachlorophenol: Chemistry, Pharmacology, and Environmental Toxicology, Rao, K.R. (editor), pp. 27 - 39, Plenum Press, New York.

Mills, W.B., and others, 1983, Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface Waters and Ground Water, Volumes 1 and 2, prepared by Tetra Tech Inc.(Lafayette, CA) and USEPA Center for Water Quality Modeling (Athens GA), January 1983.

Nimmi, A.J. and Cho, C.Y., 1983, Laboratory and Field Analysis of Pentachlorophenol accumulation by salmonids, Water Resources 17:1791-1795.

NIOSH, 1984, Current Intelligence Bulletin 40, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD, "dioxin"), United States Department of Health and Human Services, NIOSH Publication 84-104, 20 p.

NRCC, 1981, Polychlorinated dibenzo-p-dioxins: Criteria for their Effects on Man and his Environment, National Resource Council of Canada, Publication NRCC No. 18574, 251 p.

Palmer, C.D. and Johnson, R.L., 1989, Physical Processes Controlling the Transport of Non-Aqueous Phase Liquids in the Subsurface, in Transport and Fate of Contaminants in the Subsurface: Seminar Publication, EPA/625/4-89/019, USEPA Center for Environmental Research Information (Cincinnati, OH), September 1989.

Pennsylvania Code, Title 25, Chapter 93, Drainage List G, 1979.

Pignatello, J.J., Johnson, L.K., Martinson, M.M., Carlson, R.E., and Crawford, R.L., 1985, Response of the Microflora in Outdoor Experimental Streams to

AR300919

Pentachlorophenol: Compartmental Contributions, Applied Environmental Microbiology, 32: 38-46.

Ramel, C. (editor), 1978, Chlorinated Phenoxy Acids and their dioxins, Ecological Bulletin No. 27, 302 p.

R. E. Wright Associates, Inc., (REWAI) 1988. Final Remedial Investigation Report, Havertown PCP Site, Haverford Township, Delaware County, PA.

R. E. Wright Associates, Inc., (REWAI) 1989. Results of Borehole Geophysical Testing at the Havertown PCP Site.

R. E. Wright Associates, Inc., 1989. Results of an Oil Recovery Testing Program at the Havertown PCP Site.

SMC-Martin, Inc., 1982. Assessment of Groundwater Contaminated by PCP; Naylor's Run and Vicinity, Haverford Township, Delaware County, PA.

Tetra Tech, 1986, ENVSIM: A Microcomputer Program for Toxicant Transport in Ground Waters and Rivers, Tetra Tech Inc., Lafayette, CA.

Tetra Tech, Inc., 1990. Bioaccumulation of Selected Pollutants in Fish - A National Study, Volume I, U. S. Environmental Protection Agency, Washington, D.C., EPA 506/6-90/00/a.

Todd, A.S., 1984, Evaluation of National Wood Preservation, Inc. Facilities, Haverford Township, Stewart-Todd Associates, Inc.

United States Department of Agriculture, Soil Conservation Service, 1963, Soil Survey for Chester and Delaware Counties, PA.

USEPA, 1989a, Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water: A Compendium of Examples, EPA/540/2-89/057, Office of Emergency and Remedial Response, Washington, D.C., October 1989.

AK300920

USEPA, 1989b, Record of Decision for the Havertown PCP site, Haverford Township, Havertown, PA, 6/29/89.

Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, V. 30, pp 377-392.

Wilson, J.L. and Miller, P.J., 1978, Two-Dimensional Plume in Uniform Ground-Water Flow, Journal of the Hydraulic Division, ASCE, Volume 104, Number 4, pp. 503-514.

Wong, A.S. and Crosby, D.G., 1978, Photolysis of Pentachlorophenol in Water, in Pentachlorophenol: Chemistry, Pharmacology, and Environmental Toxicology, Rao, K.R. (editor), pp. 119 - 125, Plenum Press, New York.

AR300921

APPENDIX A
ECOLOGICAL FIELD METHODOLOGIES

AR300922

LOTIC MACROINVERTEBRATE SAMPLING PROCEDURE

1.0 Scope of Sampling Plan

The sampling of a lotic macroinvertebrate population, in relation to potentially impacted areas or hazardous wastes site, can provide information which can aid in evaluating potential environmental impacts from direct and/or indirect contamination. This sampling plan provides methods for the collection and analyses of a preliminary lotic macroinvertebrate investigation.

2.0 Methods

The focus of the methods is to gain qualitative information on the benthic macroinvertebrate community by collecting aquatic insects, and other related organisms, in conjunction with other detailed observations concerning the physical characteristics of the stream and related terrestrial flora and fauna associated with the stream.

Riffle/Runs and Coarse Particulate Organic Matter (CPOM) areas are typically the two primary sampling categories in lotic waters. Each will be sampled separately using various methods.

2.1 Selecting Sample Locations

Ideally, all sample locations should have similar physical and botanical features. A trained professional will select the best available and accessible areas that will be sampled. Examples of variables considered are stream size, flow rate, surrounding terrestrial habitats, depth, nearby man-made structures, and seasonal influences. After sample locations are selected, all locations should be sampled within as small a time frame of each other as possible.

2.2 Riffle/Run Methodology

Riffle/run areas are moderately fast flowing waters where there is little sedimentary deposits. The substrate could range from a small, gravel sized bed to large boulders and bedrock. Due this large potential for variations in riffle/run substrate three sampling techniques may be employed during collection: Surber stream bottom sampling, D-Frame kick net sampling, and/or drift net sampling.

2.2.1 Surber Stream Bottom Sampling

Surber stream bottom sampling will be used in open streams where the depth is less than one foot (30 cm). The Surber stream bottom sampler (Surber) samples a one square foot section of the stream bed.

A field sampler will walk, from a down stream location, to the selected location and place the Surber on the stream bed firmly. Any large rocks or debris will be brushed clean within the sample chamber thus letting any attached

AD 300923

organisms drift into the net. After the rock has been brushed, it is discarded to a down stream location. After all the large rocks are brushed, the remaining gravel is agitated towards the center of the chamber using a trowel.

Upon completion, the net is taken to the bank and emptied into a white tray containing one inch of water. This method will be performed three times. The sampler should try to obtain samples from location representative of all the riffle/run substrates and flows at that stream section.

2.2.2 D-Frame Net Sampling

D-Frame net sampling is used in areas where the depth is over one foot (30 cm), in situation where the Surber is too cumbersome or large to be used, and/or where the current is so strong that the Surber forms a "pressure head" causing the water to flow around the net.

The sampler will walk upstream to the desired location and place the flat edge of the D-Frame net on the stream bed. The sampler will proceed to brush rocks and agitate the substrate immediately upstream of the net using his/her foot for thirty seconds. Immediately after agitation, lift the net in an upstream motion and empty the contents into a white tray containing one inch of water. Repeat this process until the different riffle/run areas of the stream section have been sampled. Three to six samples should be sufficient.

2.2.3 Drift Net Sampling

Drift net sampling is used in areas of fast currents and/or deep water. Also drift net sampling offers fast sample collection of larger areas where low populations are expected.

Place the drift net down stream of sample location with the net at an one o'clock position with the upper edge leaning slightly downstream. Stretch the net across the desired section of stream and anchor it manually, use stakes, or tie the net to the stream bank. The low edge of the net should be flat on the stream bottom. The upper edge of the net should be one inch below the surface to let floating debris pass. The sampler then agitates a one square meter area of the substrate with his/her boots. After the agitation is complete, the net is lifted in an up stream motion being careful not to let the current push collected organisms over the upper edge of the net or under the lower edge of the net. Place the net on the bank for organism collection.

2.3 CPOM Methodology

CPOM areas in lotic waters are found in pools, along stream banks, on large debris, on vegetation, and other depositional areas where riffle/run flow is not present. The substrate in these areas typically consist of a mixture of leafy matter, twigs, needles and sediment. Ideally, the areas which have CPOM that is 50% decomposed is considered optimal for sampling. D-Frame net sampling and hand sampling are the two sampling methods which will be used to sample organisms found in CPOM. When sampling in CPOM areas, the sampler should try to sample a comparable total volume that had been taken during the riffle/run sampling.

2.3.1 D-Frame Net Sampling

The D-Frame net is used to sample CPOM when collection is being performed in waters with depths greater than three quarters the sampler's arm length, in pools and/or other unreachable locations.

The sampler will slowly sweep the net forward through the CPOM while gently agitating the net forward and backwards, loosening the material as the net moves. Take care not to tear the net on snags or sharp edges. The CPOM collection should not exceed more than one half the net holding capacity.

Once the CPOM is collected, the material is rinsed by dipping the collected CPOM in the stream and keeping the open end of the net facing up and out of the water. This rinses the finer particulate matter from the sample thus facilitating the invertebrate collection. After the sample is sufficiently rinsed the CPOM is placed in a white tray containing one inch of water. The net is to be carefully checked for organisms. This process is repeated until sufficient CPOM volumes have been sampled.

2.3.2 Hand Sampling

Hand sampling is performed in shallow areas and/or situations where the D-Frame net can not be used. Care should be taken to disturb the CPOM as little as possible while taking the sample.

Two to three handfuls of CPOM is collected and placed into either a D-Frame Net or a wash bucket. The CPOM is then rinsed until the small particulate matter is rinsed out of the CPOM. The CPOM is then placed into a white tray containing one inch of water.

2.4 Organism Collection

Riffle/run samples and CPOM samples will be placed in separate trays, and will be stored in separate containers. The organisms are then collected out of the trays using soft forceps and pipets, and are placed into jars containing either 40% isopropanol, 70% ethanol, or water. The organisms that were placed into water will later be placed in near boiling water and then transferred into 40% isopropanol or 70% ethanol. This process aids in the preservation of the organisms necessary for proper identification.

For lotic investigation, approximately 50 organisms for riffle/run sampling and 25 organisms for CPOM sampling should be adequate to qualitatively characterize a sampling area.

2.4.1 Field Preservation

Organisms placed directly into 40% isopropanol or 70% ethanol need no further field preservation. Organisms which were placed into jars containing stream water must be kept in a cooler lined with ice until the end of the sampling day, where further preservation will be performed. The organisms are not to be frozen.

AR300925

2.4.2 Sample Storage and Transportation

Samples containers will be pre-labeled on the outside of the containers. A paper tag will be placed directly into the solution. Labeling parameters include: site name, location, date, time, collectors names, and designation of riffle/run or CPOM. Each sample container will be place into a separate zip-lock bag and placed into a cooler. Coolers will be packed with vermiculite.

3.0 Stream Characterization

In addition to the macroinvertebrate collection, a detailed characterization of the sample area will be recorded and photographed. Parameters will routinely be recorded on a field data sheet (Figure 1).

4.0 Equipment

Surber Stream Bottom Sampler	Pencils
D-Frame Net Sampler	Ice
Drift Net	Coolers
Stakes	Vermiculite
Med. Nylon Rope	Zip-lock Bags
Trowels	Field Lenses
Wash Buckets	Field Scope
Hip/Chest Waders	Pinning Forceps
White Trays 10" X 12" X 4"	Medium Point Forceps
Wide Mouth Jars	Cushion (soft) forceps
Stiff Bristle Brushes	DI water
Tape Measure 100' (30 m)	Field Data Sheets
Metal Rule 48" (120 cm)	Hot-pot
Stop Watch	Camera
Paper tags 0.5" X 1"	
Sharpie Permanent Markers	

5.0 Reagents

40% Isopropanol
70% Ethanol

6.0 Decontamination

After each site is sampled all equipment will be washed and decontaminated as needed. Sampling nets will be rinsed only. At the end of each sampling day all equipment will be thoroughly cleaned prior to packing.

7.0 Interference and Potential Problems

There are potential interference and problem which may hinder the sampling effort. Addressing such problems in advance may aid in avoiding or coping with such incidences if they should occur.

- ° Gaining timely site access.
- ° Gaining weather forecasts for sampling event to anticipate problems caused by high flow rates due to storm events.

AR300926

FIGURE 1

STREAM SAMPLING DATA SHEET

Site Name:

Township:

County:

State:

Sample Station					
Tracking Number					
Date					
Time					
Surrounding Land Use (%)					
Forest					
Field/Pasture					
Agriculture					
Residential/Maintained					
Commercial					
Industrial					
Other:					
Watershed Erosion					
Estimated Stream Width (m)					
Estimated Stream Depth (m)					
% Riffle					
% Run					
% Pool					
Estimated Stream Velocity					
Estimated Stream Flow					
High Water Mark					
Man-Made Modifications					
Canopy Cover (%)					
Sediment/Substrate					
Odor					
Oil					
Deposits					

AR300927

STREAM SAMPLING DATA SHEET (cont'd)

Sample Station					
Dominant Substrate Type (Inorganic)					
% Bedrock					
% Boulder (>0.25m)					
% Cobble (0.065 - 0.25m)					
% Gravel (0.002 - 0.065m)					
% Sand (gritty)					
% Silt (fine)					
% Clay (slick)					
Dominant Substrate Type (Organic)					
% Detritus					
% Muck/Mud					
% Marl					
Overall Water Qual.					
Water Temperature (°C)					
pH (units)					
Diss. Oxygen (mg/L)					
Conductivity (mΩ/cm)					
Eh (mV)					
Instruments Used					
Stream Type					
Stream Odor					
Stream Oils					
Stream Turbidity					
Weather Conditions			Photographs/Numbers		
<p align="center">Stream Observations/Sketch</p> <p align="right">AR300928</p>					

STREAM SAMPLING DATA SHEET (cont'd)

Conditions - Parameters

Sample Stations					
-----------------	--	--	--	--	--

Primary - Substrate & Instream Cover

1. Bottom substrate and available cover					
2. Embeddedness					
3. Flow					

Secondary - Channel Morphology

4. Channel alteration					
5. Bottom scouring and deposition					
6. Pool/riffle, run/bend ratio					

Tertiary - Riparian & Bank Structure

7. Bank Stability					
8. Bank Vegetation					
9. Stream Side Cover					

Comparisons

Total Score					
Percent of Comparability to Reference					
Station Assessment Compared to Reference					

Conditions	Excellent	Good	Fair	Poor	Assessment Category	Percent of Comparability
Primary	16-20	11-15	6-10	0-5	Comparable to Reference	>89%
Secondary	12-15	8-11	4-7	0-3	Supporting	75-88%
Tertiary	9-10	6-8	3-5	0-2	Partially Supporting	60-73%
					Non Supporting	<59%

AR300929

STREAM SAMPLING DATA SHEET

Benthic Collection

Sample Station					
----------------	--	--	--	--	--

Observed Relative Abundance of Aquatic Biota

Periphyton					
Slime					
Filamentous Algae					
Macroinvertebrate					
Macrophytes					
Fish					

0 = Absent/Not Observed 1 = Rare 2 = Common 3 = Abundant 4 = Dominant

Sample Type

Rifle/Run	Surber					
	Driftnet					
	D-Frame					
CPOM	D-Frame					
	Hand					
Collectors	1.					
	2.					
	3.					
Preservatives	1.					
	2.					
	3.					

Additional Comments

AR300930

- ° Taking into account seasonal factors, such as freezing temperatures, accessibility, and seasonal variation in benthic populations, which may result in additional time needed for collection.
- ° Estimating impacts due to contaminants resulting in additional time needed to obtain organisms.

8.0 Calculations

No calculation will be performed until after samples have been analyzed.

9.0 Quality Assurance/Quality Control

- ° All data will be documented on field data sheets or within the field logbook.
- ° All sampling plans will include a sampling a reference area.
- ° All deliverables must be peer reviewed prior to release.

10.0 References

- US EPA. 1989. "Rapid Bioassessment Protocols For Use In Streams And Rivers." EPA/444/4-89/001.
- Weston, Roy F. 1989. Qualitative Technology Procedures No. 3.33 Aquatic Biological Surveys.
- Weston, Roy F., EPA Response Engineering & Analytical Contract. 1989. "Benthic Sampling: Draft".

AR300931

APPENDIX B
GROUND-WATER DATA
November, 1990

AR300932

GLOSSARY OF DATA QUALIFIER CODES

CODES RELATING TO IDENTIFICATION

(confidence concerning presence or absence of compounds):

- U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.
- (NO CODE) = Confirmed identification.
- B = Not detected substantially above the level reported in laboratory or field blanks.
- R = Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
- N = Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts.

CODES RELATED TO QUANTITATION

(can be used for both positive results and sample quantitation limits):

- J = Analyte present. Reported value may not be accurate or precise.
- K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
- L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
- UJ = Not detected, quantitation may be inaccurate or imprecise.
- UL = Not detected, quantitation limit is probably higher.

OTHER CODES

- Q = No analytical result.
- D = Compound identified in an analysis at a secondary dilution factor.
- X = Additional flags defined separately.

AR300933

APPENDIX B-1
VOLATILE ORGANIC COMPOUND DATA
IN GROUND WATER - 1990

AR300934

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-1S		CW-2S		CW-3S		CW-4S		CW-5S	
Chloromethane	50	U	100	U	10	U	10	UJ	10	U
Bromomethane	50	U	100	U	10	U	10	U	10	U
Vinyl chloride	50	U	100	U	10	U	6	J	10	U
Chloroethane	50	U	100	U	10	U	10	U	10	U
Methylene Chloride	8	J	17	B	2	B	5	B	5	UJ
Acetone	50	U	100	U	10	U	10	U	10	U
Carbon Disulfide	25	U	50	U	5	U	5	U	3	J
1,1-Dichloroethene	25	U	50	U	5	U	5	U	5	U
1,1-Dichloroethane	25	U	50	U	5	U	5	U	5	U
1,2-Dichloroethene	270		50	U	5	U	50		5	U
Chloroform	25	U	50	U	5	U	5	U	5	U
1,2-Dichloroethane	25	U	50	U	5	U	5	U	5	U
2-Butanone	50	U	100	U	10	U	10	U	10	U
1,1,1-Trichloroethane	25	U	50	U	5	U	5	U	5	U
Carbon Tetrachloride	25	U	50	U	5	U	5	U	5	U
Vinyl Acetate	50	UJ	100	U	10	UJ	10	U	10	U
Bromodichloromethane	25	U	50	U	5	U	5	U	5	U
1,2-Dichloropropane	25	U	50	U	5	U	5	U	5	U
cis-1,3-Dichloropropene	25	U	50	U	5	U	5	U	5	U
Trichloroethene	630		50	U	5	U	50		5	U
Dibromochloromethane	25	U	50	U	5	U	5	U	5	U
1,1,2-Trichloroethane	25	U	50	U	5	U	5	U	5	U
Benzene	25	U	50	U	5	U	120		7	
Trans-1,3-Dichloropropene	25	U	50	U	5	U	5	U	5	U
Bromoform	25	U	50	U	5	U	5	U	5	U
4-Methyl-2-Pentanone	50	U	100	U	10	UJ	10	U	10	U
2-Hexanone	50	U	100	U	10	U	10	U	10	U
Tetrachloroethene	25	U	50	U	5	U	5	U	5	U
1,1,2,2,-Tetrachloroethane	25	U	50	U	5	U	5	UJ	5	U
Toluene	25	U	50	U	5	U	5	U	5	U
Chlorobenzene	25	U	50	U	5	U	5	U	5	U
Ethylbenzene	25	U	50	U	5	U	5	U	160	
Styrene	25	U	50	U	5	UJ	5	U	5	UJ
Total Xylenes	25	U	110		5	UJ	97		260	

**HARTTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-6S		HAV-02		HAV-04		HAV-05		HAV-07	
Chloromethane	10	UJ	500	U	1000	UJ	1000	UJ	10	U
Bromomethane	10	U	500	U	1000	U	1000	U	10	U
Vinyl chloride	10	U	500	U	1000	U	1000	U	10	U
Chloroethane	10	U	500	U	1000	U	1000	U	10	U
Methylene Chloride	2	B	110	J	590		380	J	5	UJ
Acetone	10	U	500	U	1000	U	1000	U	10	U
Carbon Disulfide	5	U	250	U	500	U	500	U	5	U
1,1-Dichloroethene	5	U	250	U	500	U	500	U	5	U
1,1-Dichloroethane	5	U	250	U	500	U	500	U	5	U
1,2-Dichloroethene	1	J	250	U	500	U	500	U	2	J
Chloroform	5	U	250	U	500	U	500	U	5	U
1,2-Dichloroethane	5	U	250	U	500	U	500	U	5	U
2-Butanone	10	U	500	U	1000	U	1000	U	10	U
1,1,1-Trichloroethane	5	U	250	U	500	U	500	U	5	U
Carbon Tetrachloride	5	U	250	U	500	U	500	U	5	U
Vinyl Acetate	10	UJ	500	U	1000	UJ	1000	UJ	10	U
Bromodichloromethane	5	U	250	U	500	U	500	U	5	U
1,2-Dichloropropane	5	U	250	U	500	U	500	U	5	U
cis-1,3-Dichloropropene	5	U	250	U	500	U	500	U	5	U
Trichloroethene	5	U	250	U	500	U	500	U	1	J
Dibromochloromethane	5	U	250	U	500	U	500	U	5	U
1,1,2-Trichloroethane	5	U	250	U	500	U	500	U	5	U
Benzene	5	U	250	U	230	J	68	J	5	U
Trans-1,3-Dichloropropene	5	U	250	U	500	U	500	U	5	U
Bromoform	5	U	250	U	500	U	500	U	5	U
4-Methyl-2-Pentanone	10	UJ	500	U	1000	UJ	1000	UJ	10	U
2-Hexanone	10	U	500	U	1000	U	1000	U	10	U
Tetrachloroethene	5	U	250	U	500	U	500	U	5	U
1,1,2,2-Tetrachloroethane	5	U	250	U	500	U	500	U	5	U
Toluene	5	U	250	U	500	U	500	U	5	U
Chlorobenzene	5	U	250	U	500	U	500	U	5	U
Ethylbenzene	5	U		U	500	U	500	U	5	U
Styrene	5	U	250	U	500	U	500	U	5	UJ
Total Xylenes	5	UJ	240	J	1300	J	1700	J	5	U

HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS
 $\mu\text{g/L}$
NOVEMBER, 1990

TCN 4212
 R1 REPORT
 REV. #1
 21/JUN/91

VOLATILE ORGANICS	HAV-08	
Chloromethane	10	U
Bromomethane	10	U
Vinyl chloride	3	J
Chloroethane	10	U
Methylene Chloride	5	UJ
Acetone	10	U
Carbon Disulfide	5	U
1,1-Dichloroethene	5	U
1,1-Dichloroethane	5	U
1,2-Dichloroethene	13	
Chloroform	5	U
1,2-Dichloroethane	5	U
2-Butanone	10	U
1,1,1-Trichloroethane	5	U
Carbon Tetrachloride	5	U
Vinyl Acetate	10	U
Bromodichloromethane	5	U
1,2-Dichloropropane	5	U
cis-1,3-Dichloropropene	5	U
Trichloroethene	15	
Dibromochloromethane	5	U
1,1,2-Trichloroethane	5	U
Benzene	32	
Trans-1,3-Dichloropropene	5	U
Bromoform	5	U
4-Methyl-2-Pentanone	10	U
2-Hexanone	10	U
Tetrachloroethene	5	U
1,1,2,2-Tetrachloroethane	5	U
Toluene	5	U
Chlorobenzene	5	U
Ethylbenzene	5	UJ
Styrene	5	U
Total Xylenes	53	

AR300937

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-1I		CW-2I		CW-3I		CW-4I		CW-5I	
Chloromethane	50	U	100	U	10	U	20	U	20	U
Bromomethane	50	U	100	U	10	U	20	U	20	U
Vinyl chloride	12	J	100	U	10	U	20	U	20	U
Chloroethane	50	U	100	U	10	U	20	U	20	U
Methylene Chloride	7	B	20	B	5	U	10	U	10	U
Acetone	50	U	100	U	10	U	39	B	5	B
Carbon Disulfide	25	U	50	U	5	U	10	U	10	U
1,1-Dichloroethene	25	U	50	U	5	U	10	U	10	U
1,1-Dichloroethane	25	U	50	U	5	U	10	U	10	U
1,2-Dichloroethene	220		50	U	5	U	23		10	U
Chloroform	25	U	50	U	5	U	10	U	10	U
1,2-Dichloroethane	25	U	50	U	5	U	10	U	10	U
2-Butanone	50	U	100	U	10	U	3	J	20	U
1,1,1-Trichloroethane	25	U	50	U	5	U	10	U	10	U
Carbon Tetrachloride	25	U	50	U	5	U	10	U	10	U
Vinyl Acetate	50	UJ	100	UJ	10	UJ	20	UJ	20	U
Bromodichloromethane	25	U	50	U	5	U	10	U	10	U
1,2-Dichloropropane	25	U	50	U	5	U	10	U	10	U
cis-1,3-Dichloropropene	25	U	50	U	5	U	10	U	10	U
Trichloroethene	430		50	U	5	U	25		10	U
Dibromochloromethane	25	U	50	U	5	U	10	U	10	U
1,1,2-Trichloroethane	25	U	50	U	5	U	10	U	10	U
Benzene	25	U	50	U	5	U	270		7	J
Trans-1,3-Dichloropropene	25	U	50	U	5	U	10	U	10	U
Bromoform	25	U	50	U	5	U	10	U	10	U
4-Methyl-2-Pentanone	50	U	100	U	10	UJ	2	J	20	U
2-Hexanone	50	U	100	U	10	U	20	U	20	U
Tetrachloroethene	25	U	50	U	5	U	10	U	10	U
1,1,2,2-Tetrachloroethane	25	U	50	U	5	U	10	U	10	UJ
Toluene	25	U	50	U	5	U	92		10	U
Chlorobenzene	25	U	50	U	5	U	10	U	10	U
Ethylbenzene	25	U	50	U	5	U	10	U	10	U
Styrene	25	U	50	U	5	UJ	10	U	10	U
Total Xylenes	25	U	79		5	UJ	540	J	190	

HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS
 $\mu\text{g/L}$
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-6I		CW-6I-DUP		CW-11-DUP		R-2		R-4	
Chloromethane	10	U	10	UJ	50	U	2000	U	10	U
Bromomethane	10	U	10	U	50	U	2000	U	10	U
Vinyl chloride	10	U	10	U	21	J	2000	U	10	U
Chloroethane	10	U	10	U	5	J	2000	U	10	U
Methylene Chloride	5	U	5	U	22	B	1000	U	5	U
Acetone	3	B	10	U	50	U	2000	U	10	U
Carbon Disulfide	5	U	5	U	25	U	1000	U	5	U
1,1-Dichloroethene	5	U	5	U	25	U	1000	U	5	U
1,1-Dichloroethane	5	U	5	U	25	U	1000	U	5	U
1,2-Dichloroethene	39		39		270		1000	U	5	U
Chloroform	5	U	5	U	25	U	1000	U	5	U
1,2-Dichloroethane	5	U	5	U	25	U	1000	U	5	U
2-Butanone	10	U	10	U	50	U	2000	U	10	U
1,1,1-Trichloroethane	5	U	5	U	25	U	1000	U	5	U
Carbon Tetrachloride	5	U	5	U	25	U	1000	U	5	U
Vinyl Acetate	10	UJ	10	UJ	50	U	2000	U	10	U
Bromodichloromethane	5	U	5	U	25	U	1000	U	5	U
1,2-Dichloropropane	5	U	5	U	25	U	1000	U	5	U
cis-1,3-Dichloropropene	5	U	5	U	25	U	1000	U	5	U
Trichloroethene	30		26		500		1000	U	5	U
Dibromochloromethane	5	U	5	U	25	U	1000	U	5	U
1,1,2-Trichloroethane	5	U	5	U	25	U	1000	U	5	U
Benzene	4	J	4	J	25	U	1000	U	5	U
Trans-1,3-Dichloropropene	5	U	5	U	25	U	1000	U	5	U
Bromoform	5	U	5	U	25	U	1000	U	5	U
4-Methyl-2-Pentanone	10	U	10	UJ	50	U	2000	U	10	U
2-Hexanone	10	U	10	U	50	U	2000	U	10	U
Tetrachloroethene	5	U	5	U	25	U	1000	U	5	U
1,1,2,2-Tetrachloroethane	5	U	5	U	25	U	1000	U	5	U
Toluene	5	U	5	U	25	U	1000	U	5	U
Chlorobenzene	5	U	5	U	25	U	1000	U	5	U
Ethylbenzene	5	U	5	U	25	U	1000	U	5	U
Styrene	5	U	5	U	25	U	1000	U	5	U
Total Xylenes	56	J	53	J	25	U	1000	U	5	U

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	NW-1		NW-3		NW-6	
Chloromethane	50	U	10	U	10	U
Bromomethane	50	U	10	U	10	U
Vinyl chloride	50	U	10	U	8	J
Chloroethane	50	U	10	U	10	U
Methylene Chloride	25	U	6	B	5	U
Acetone	50	U	12		13	B
Carbon Disulfide	25	U	5	U	5	U
1,1-Dichloroethene	25	U	5	U	5	U
1,1-Dichloroethane	25	U	5	U	5	U
1,2-Dichloroethene	25	U	5	U	26	
Chloroform	25	U	5	U	5	U
1,2-Dichloroethane	25	U	5	U	5	U
2-Butanone	50	U	10	UJ	10	U
1,1,1-Trichloroethane	25	U	5	U	5	U
Carbon Tetrachloride	25	UJ	5	U	5	U
Vinyl Acetate	50	U	10	UJ	10	UJ
Bromodichloromethane	25	U	5	U	5	U
1,2-Dichloropropane	25	U	5	U	5	U
cis-1,3-Dichloropropene	25	U	5	U	5	U
Trichloroethene	25	U	5	U	5	
Dibromochloromethane	25	U	5	U	5	U
1,1,2-Trichloroethane	25	U	5	U	5	U
Benzene	25	U	5	U	1	J
Trans-1,3-Dichloropropene	25	U	5	U	5	U
Bromoform	25	U	5	U	5	U
4-Methyl-2-Pentanone	50	UJ	10	UJ	10	U
2-Hexanone	50	U	10	U	10	U
Tetrachloroethene	25	U	5	U	5	U
1,1,2,2-Tetrachloroethane	25	U	5	UJ	5	U
Toluene	25	U	5	U	5	U
Chlorobenzene	25	U	5	U	5	U
Ethylbenzene	25	U	5		5	U
Styrene	25	U	5		5	U
Total Xylenes	25	UJ	3	J	2	J

AR300940

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-1D		CW-2D		CW-3D		CW-4D		CW-5D	
Chloromethane	50	U	10	U	10	UJ	20	U	20	U
Bromomethane	50	U	10	U	10	U	20	U	20	U
Vinyl chloride	50	U	10	U	10	U	20	U	20	U
Chloroethane	50	U	10	U	10	U	20	U	20	U
Methylene Chloride	25	U	5	U	1	B	10	U	10	U
Acetone	50	U	10	U	8	B	26	B	10	U
Carbon Disulfide	25	U	5	U	5	U	10	U	10	U
1,1-Dichloroethene	25	U	5	U	5	U	10	U	10	U
1,1-Dichloroethane	25	U	5	U	5	U	10	U	10	U
1,2-Dichloroethene	160		5	U	5	U	13		10	U
Chloroform	25	U	5	U	5	U	10	U	10	U
1,2-Dichloroethane	25	U	5	U	5	U	10	U	10	U
2-Butanone	50	U	10	U	10	U	20	UJ	20	U
1,1,1-Trichloroethane	25	U	5	U	5	U	10	U	10	U
Carbon Tetrachloride	25	UJ	5	UJ	5	U	10	U	10	U
Vinyl Acetate	50	UJ	10	U	10	UJ	20	UJ	20	U
Bromodichloromethane	25	U	5	U	5	U	10	U	10	U
1,2-Dichloropropane	25	U	5	U	5	U	10	U	10	U
cis-1,3-Dichloropropene	25	U	5	U	5	U	10	U	10	U
Trichloroethene	390		3	J	1	J	19		10	U
Dibromochloromethane	25	U	5	U	5	U	10	U	10	U
1,1,2-Trichloroethane	25	U	5	U	5	U	10	U	10	U
Benzene	25	U	1	J	5	U	220		13	
Trans-1,3-Dichloropropene	25	U	5	U	5	U	10	U	10	U
Bromoform	25	U	5	U	5	U	10	U	10	U
4-Methyl-2-Pentanone	50	U	10	UJ	10	UJ	20	U	20	U
2-Hexanone	50	U	10	U	10	U	20	U	20	U
Tetrachloroethene	25	U	5	U	5	U	10	U	10	U
1,1,2,2,-Tetrachloroethane	25	U	5	U	5	U	10	U	10	U
Toluene	25	U	2	J	5	U	77		10	U
Chlorobenzene	25	U	5	U	5	U	10	U	10	U
Ethylbenzene	25	U	5	U	5	U	10	U	10	U
Styrene	25	U	5	U	5	U	10	U	10	U
Total Xylenes	25	U	3	J	5	UJ	340	J	390	

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

VOLATILE ORGANICS	CW-6D	
Chloromethane	10	U
Bromomethane	10	U
Vinyl chloride	10	U
Chloroethane	10	U
Methylene Chloride	0.7	B
Acetone	7	B
Carbon Disulfide	5	U
1,1-Dichloroethene	5	U
1,1-Dichloroethane	5	U
1,2-Dichloroethene	21	
Chloroform	5	U
1,2-Dichloroethane	5	U
2-Butanone	10	U
1,1,1-Trichloroethane	5	U
Carbon Tetrachloride	5	U
Vinyl Acetate	10	UJ
Bromodichloromethane	5	U
1,2-Dichloropropane	5	U
cis-1,3-Dichloropropene	5	U
Trichloroethene	17	
Dibromochloromethane	5	U
1,1,2-Trichloroethane	5	U
Benzene	3	J
Trans-1,3-Dichloropropene	5	U
Bromoform	5	U
4-Methyl-2-Pentanone	10	U
2-Hexanone	10	U
Tetrachloroethene	5	U
1,1,2,2-Tetrachloroethane	5	U
Toluene	5	U
Chlorobenzene	5	U
Ethylbenzene	5	U
Styrene	5	U
Total Xylenes	34	J

AR300942

TCN 4212
RI REPORT
REV. #1
21/JUN/91

APPENDIX B-2
SEMI-VOLATILE ORGANIC COMPOUND DATA
IN GROUND WATER - 1990

AR300943

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

µg/L
NOVEMBER, 1990

TCN 4212

RJ REPORT

REV. #1

21/JUN/91

SEMI-VOLATILE ORGANICS	CW-1S		CW-2S		CW-3S		CW-4S		CW-5S	
Phenol	11	R	1000	R	20	U	400	U	10	U
bis(2-Chloroethyl)Ether	11	U	1000	U	20	UJ	400	U	10	U
2-Chlorophenol	11	R	1000	R	20	U	400	U	10	U
1,3-Dichlorobenzene	11	U	1000	U	20	U	400	U	10	U
1,4-Dichlorobenzene	11	U	1000	U	20	U	400	U	10	U
Benzyl Alcohol	11	R	1000	R	20	UJ	400	UJ	10	U
1,2-Dichlorobenzene	11	U	1000	U	20	U	400	U	10	U
2-Methylphenol	11	R	1000	R	20	U	400	U	10	U
bis(2-Chloroisopropyl)Ether	11	U	1000	U	20	U	400	U	10	U
4-Methylphenol	11	R	1000	R	20	U	400	U	10	U
N-Nitroso-Di-n-Propylamine	11	UJ	1000	UJ	20	U	400	U	10	UJ
Hexachloroethane	11	U	1000	U	20	U	400	U	10	U
Nitrobenzene	11	U	1000	U	20	U	400	U	10	U
Isophorone	11	U	1000	UJ	20	U	400	U	10	UJ
2-Nitrophenol	11	R	1000	R	20	U	400	U	10	U
2,4-Dimethylphenol	11	R	1000	R	20	U	400	U	10	U
Benzoic Acid	54	R	5000	R	100	U	2000	UJ	50	UJ
bis(2-Chloroethoxy)Methane	11	U	1000	U	20	U	400	UJ	10	U
2,4-Dichlorophenol	11	R	1000	R	20	U	400	U	10	U
1,2,4-Trichlorobenzene	11	U	1000	U	20	U	400	U	10	U
Naphthalene	11	U	2700		20	U	150	J	4	J
4-Chloroaniline	11	R	1000	U	20	U	400	U	10	U
Hexachlorobutadiene	11	U	1000	U	20	U	400	U	10	U
4-Chloro-3-Methylphenol	11	R	1000	R	20	U	400	U	10	U
2-Methylnaphthalene	11	U	1500		20	U	85	J	39	
Hexachlorocyclopentadiene	11	UJ	1000	U	20	UJ	400	U	10	U
2,4,6-Trichlorophenol	11	R	1000	R	20	U	400	U	10	U
2,4,5-Trichlorophenol	54	R	5000	R	100	U	2000	UJ	50	U
2-Chloronaphthalene	11	U	1000	U	20	U	400	U	10	U
2-Nitroaniline	54	U	5000	U	100	U	2000	UJ	50	U
Dimethyl Phthalate	11	U	1000	UJ	20	U	400	U	10	UJ
Acenaphthylene	11	U	1000	UJ	20	U	400	UJ	10	UJ
2,6-Dinitrotoluene	11	U	1000	U	20	U	400	UJ	10	U
3-Nitroaniline	54	R	5000	UJ	100	U	2000	UJ	50	U

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Conc)	CW-1S		CW-2S		CW-3S		CW-4S		CW-5S	
Acenaphthene	11	U	50	J	20	U	400	U	2	J
2,4-Dinitrophenol	54	R	5000	R	100	UJ	2000	U	50	U
4-Nitrophenol	54	R	5000	R	100	UJ	2000	U	50	U
Dibenzofuran	1	J	39	J	20	U	400	U	1	J
2,4-Dinitrotoluene	11	U	1000	U	20	U	400	UJ	10	U
Diethylphthalate	11	U	1000	UJ	20	U	400	U	10	UJ
4-Chlorophenyl-phenylether	11	U	1000	UJ	20	U	400	UJ	10	UJ
Fluorene	1	J	120	J	20	U	400	UJ	4	J
4-Nitroaniline	54	UJ	5000	U	100	U	2000	UJ	50	U
4,6-Dinitro-2-Methylphenol	54	R	5000	R	100	U	2000	U	50	U
N-Nitrosodiphenylamine (1)	11	U	1000	U	20	U	400	U	10	U
4-Bromophenyl-phenylether	11	U	1000	U	20	U	400	U	10	U
Hexachlorobenzene	11	U	1000	U	20	U	400	U	10	U
Pentachlorophenol	250	J	6800	J	100	U	3300		88	
Phenanthrene	0.7	J	310	J	20	U	400	U	6	J
Anthracene	1	J	1000	U	20	U	400	U	0.5	J
Di-n-Butylphthalate	0.5	B	1000	U	20	U	400	U	10	U
Fluoranthene	11	U	1000	U	20	U	400	U	0.3	J
Pyrene	11	U	39	J	20	UJ	400	U	0.5	J
Butylbenzylphthalate	11	UJ	1000	U	20	UJ	400	U	10	U
3,3-Dichlorobenzidine	22	R	2000	UJ	40	UJ	800	R	20	UJ
Benzo(a)Anthracene	11	U	1000	UJ	20	U	400	U	10	UJ
Chrysene	11	U	1000	U	20	U	400	U	10	U
bis(2-Ethylhexyl)Phthalate	5	B	1000	U	16	B	400	U	1	B
Di-n-Octyl Phthalate	11	U	1000	UJ	20	U	400	U	10	UJ
Benzo(b)Fluoranthene	11	U	1000	U	20	U	400	U	10	U
Benzo(k)Fluoranthene	11	UJ	1000	UJ	20	UJ	400	UL	10	UJ
Benzo(a)Pyrene	11	U	1000	U	20	U	400	U	10	U
Indenol(1,2,3-cd)Pyrene	11	U	1000	UJ	20	UJ	400	U	10	U
Dibenz(a,h)Anthracene	11	U	1000	UJ	20	UJ	400	UL	10	U
Benzo(g,h,i)Perylene	11	U	1000	UJ	20	UJ	400	UL	10	U

AR300945

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	CW-6S		HAV-02		HAV-04		HAV-05		HAV-07	
Phenol	20	U	520	R	4600	R	400	U	10	U
bis(2-Chloroethyl)Ether	20	U	520	R	4600	U	400	U	10	U
2-Chlorophenol	20	U	520	R	4600	R	400	U	10	U
1,3-Dichlorobenzene	20	U	520	R	4600	U	400	U	10	U
1,4-Dichlorobenzene	20	U	520	R	4600	U	400	U	10	U
Benzyl Alcohol	20	UJ	520	R	4600	R	400	UJ	10	U
1,2-Dichlorobenzene	20	U	520	R	4600	U	400	U	10	U
2-Methylphenol	20	U	520	R	4600	R	400	U	10	U
bis(2-Chloroisopropyl)Ether	20	U	520	R	4600	U	400	U	10	U
4-Methylphenol	20	U	520	R	4600	R	400	U	10	U
N-Nitroso-Di-n-Propylamine	20	U	520	R	4600	U	400	U	10	U
Hexachloroethane	20	U	520	R	4600	U	400	U	10	U
Nitrobenzene	20	U	520	R	4600	U	400	U	10	U
Isophorone	20	U	520	R	4600	U	400	U	10	U
2-Nitrophenol	20	U	520	R	4600	R	400	U	10	U
2,4-Dimethylphenol	20	U	520	R	4600	R	400	U	10	U
Benzoic Acid	100	UJ	2600	R	23000	R	2000	UJ	50	U
bis(2-Chloroethoxy)Methane	20	UJ	520	R	4600	U	400	UJ	10	U
2,4-Dichlorophenol	20	U	520	R	4600	R	400	U	10	U
1,2,4-Trichlorobenzene	20	U	520	R	4600	U	400	U	10	U
Naphthalene	20	U	670	L	12000		270	J	10	U
4-Chloroaniline	20	U	520	R	4600	U	400	U	10	U
Hexachlorobutadiene	20	U	520	R	4600	U	400	U	10	U
4-Chloro-3-Methylphenol	20	U	520	R	4600	R	400	U	10	U
2-Methylnaphthalene	20	U	260	J	8000		160	J	10	U
Hexachlorocyclopentadiene	20	U	520	R	4600	U	400	U	10	U
2,4,6-Trichlorophenol	20	U	520	R	4600	R	400	U	10	U
2,4,5-Trichlorophenol	100	UJ	2600	R	23000	R	2000	UJ	50	U
2-Chloronaphthalene	20	U	520	R	4600	U	400	U	10	U
2-Nitroaniline	100	UJ	2600	R	23000	UJ	2000	UJ	50	U
Dimethyl Phthalate	20	U	520	R	4600	U	400	U	10	U
Acenaphthylene	20	UJ	520	R	4600	UJ	400	UJ	10	U
2,6-Dinitrotoluene	20	UJ	520	R	4600	UJ	400	UJ	10	U
3-Nitroaniline	100	UJ	2600	R	23000	U	2000	UJ	50	U

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Conf'd.)	CW-6S		HAV-02		HAV-04		HAV-05		HAV-07	
Acenaphthene	20	U	520	R	870	J	14	J	10	U
2,4-Dinitrophenol	100	UJ	2600	R	23000	R	2000	U	50	U
4-Nitrophenol	100	U	2600	R	23000	R	2000	U	50	U
Dibenzofuran	20	U	520	R	630	J	400	U	10	U
2,4-Dinitrotoluene	20	U	520	R	4600	U	400	UJ	10	U
Diethylphthalate	20	U	520	R	4600	UJ	400	U	10	U
4-Chlorophenyl-phenylether	20	UJ	520	R	4600	UJ	400	UJ	10	U
Fluorene	20	UJ	24	J	4600	UJ	400	UJ	10	U
4-Nitroaniline	100	UJ	2600	R	23000	U	2000	UJ	50	U
4,6-Dinitro-2-Methylphenol	100	U	2600	R	23000	R	2000	R	50	U
N-Nitrosodiphenylamine (1)	20	U	520	R	4600	U	400	U	10	U
4-Bromophenyl-phenylether	20	U	520	R	4600	U	400	U	10	U
Hexachlorobenzene	20	U	520	R	4600	U	400	U	10	U
Pentachlorophenol	98	J	1900	J	63000	L	3300		14	J
Phenanthrene	20	U	80	J	4900		32	J	10	U
Anthracene	20	U	520	R	470	J	400	U	10	U
Di-n-Butylphthalate	0.9	J	520	R	4600	U	400	U	10	U
Fluoranthene	20	U	520	R	4600	U	400	U	10	U
Pyrene	20	U	520	R	950	J	400	U	10	U
Butylbenzylphthalate	20	U	520	R	4600	U	400	U	10	U
3,3-Dichlorobenzidine	40	R	1000	R	9200	U	800	R	20	U
Benzo(a)Anthracene	20	U	520	R	4600	U	400	U	10	U
Chrysene	20	U	520	R	4600	U	400	U	10	U
bis(2-Ethylhexyl)Phthalate	2	B	520	R	4600	U	400	U	10	U
Di-n-Octyl Phthalate	0.3	J	520	R	4600	U	400	U	10	U
Benzo(b)Fluoranthene	20	U	520	R	4600	U	400	U	10	U
Benzo(k)Fluoranthene	20	UJ	520	R	4600	UJ	400	UJ	10	UJ
Benzo(a)Pyrene	20	U	520	R	4600	U	400	U	10	U
Indenol(1,2,3-cd)Pyrene	20	U	520	R	4600	U	400	U	10	U
Dibenz(a,h)Anthracene	20	UJ	520	R	4600	U	400	UJ	10	U
Benzo(g,h,i)Perylene	20	UJ	520	R	4600	UJ	400	UJ	10	U

AR300947

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	HAV-08	
Phenol	250	U
bis(2-Chloroethyl)Ether	250	U
2-Chlorophenol	250	U
1,3-Dichlorobenzene	250	U
1,4-Dichlorobenzene	250	U
Benzyl Alcohol	250	U
1,2-Dichlorobenzene	250	U
2-Methylphenol	250	U
bis(2-Chloroisopropyl)Ether	250	U
4-Methylphenol	250	U
N-Nitroso-Di-n-Propylamine	250	UJ
Hexachloroethane	250	U
Nitrobenzene	250	U
Isophorone	250	UJ
2-Nitrophenol	250	U
2,4-Dimethylphenol	250	U
Benzoic Acid	1200	UJ
bis(2-Chloroethoxy)Methane	250	U
2,4-Dichlorophenol	250	U
1,2,4-Trichlorobenzene	250	U
Naphthalene	700	
4-Chloroaniline	250	U
Hexachlorobutadiene	250	U
4-Chloro-3-Methylphenol	250	U
2-Methylnaphthalene	130	J
Hexachlorocyclopentadiene	250	U
2,4,6-Trichlorophenol	250	U
2,4,5-Trichlorophenol	1200	U
2-Chloronaphthalene	250	U
2-Nitroaniline	1200	U
Dimethyl Phthalate	250	UJ
Acenaphthylene	250	UJ
2,6-Dinitrotoluene	250	U
3-Nitroaniline	1200	U

AR300948

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

**μg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Cont'd.)	HAV-08	
Acenaphthene	250	U
2,4-Dinitrophenol	1200	UJ
4-Nitrophenol	1200	U
Dibenzofuran	250	U
2,4-Dinitrotoluene	250	U
Diethylphthalate	250	UJ
4-Chlorophenyl-phenylether	250	UJ
Fluorene	250	U
4-Nitroaniline	1200	U
4,6-Dinitro-2-Methylphenol	1200	UJ
N-Nitrosodiphenylamine (1)	250	U
4-Bromophenyl-phenylether	250	U
Hexachlorobenzene	250	U
Pentachlorophenol	1900	
Phenanthrene	9	J
Anthracene	250	U
Di-n-Butylphthalate	250	U
Fluoranthene	250	U
Pyrene	250	U
Butylbenzylphthalate	250	U
3,3-Dichlorobenzidine	500	UJ
Benzo(a)Anthracene	250	U
Chrysene	250	U
bis(2-Ethylhexyl)Phthalate	250	U
Di-n-Octyl Phthalate	250	UJ
Benzo(b)Fluoranthene	250	U
Benzo(k)Fluoranthene	250	UJ
Benzo(a)Pyrene	250	U
Indenol(1,2,3-cd)Pyrene	250	UJ
Dibenz(a,h)Anthracene	250	UJ
Benzo(g,h,i)Perylene	250	UJ

AR300949

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	CW-1I		CW-2I		CW-3I		CW-4I		CW-5I	
Phenol	11	U	200	R	20	U	400	R	10	U
bis(2-Chloroethyl)Ether	11	U	200	U	20	UJ	400	U	10	U
2-Chlorophenol	11	U	200	R	20	U	400	R	10	U
1,3-Dichlorobenzene	11	U	200	U	20	U	400	U	10	U
1,4-Dichlorobenzene	11	U	200	U	20	U	400	U	10	U
Benzyl Alcohol	11	U	200	R	20	UJ	400	R	10	U
1,2-Dichlorobenzene	11	U	200	U	20	U	400	U	10	U
2-Methylphenol	11	U	200	R	20	U	400	R	10	U
bis(2-Chloroisopropyl)Ether	11	U	200	U	20	U	400	U	10	U
4-Methylphenol	11	U	200	R	20	U	400	R	10	U
N-Nitroso-Di-n-Propylamine	11	U	200	U	20	U	400	U	10	U
Hexachloroethane	11	U	200	U	20	U	400	U	10	U
Nitrobenzene	11	UJ	200	U	20	U	400	U	10	U
Isophorone	11	U	200	U	20	U	400	U	10	U
2-Nitrophenol	11	U	200	R	20	U	400	R	10	U
2,4-Dimethylphenol	11	U	200	R	20	U	400	R	10	U
Benzoic Acid	54	U	1000	R	100	U	2000	R	50	U
bis(2-Chloroethoxy)Methane	11	U	200	U	20	U	400	UJ	10	U
2,4-Dichlorophenol	11	U	200	R	20	U	400	R	10	U
1,2,4-Trichlorobenzene	11	U	200	U	20	U	400	U	10	U
Naphthalene	11	U	650		20	U	620		10	
4-Chloroaniline	11	UJ	200	U	20	U	400	U	10	U
Hexachlorobutadiene	11	U	200	U	20	U	400	U	10	U
4-Chloro-3-Methylphenol	11	U	200	R	20	U	400	R	10	U
2-Methylnaphthalene	11	U	270		20	U	140	J	39	
Hexachlorocyclopentadiene	11	U	200	U	20	UJ	400	U	10	U
2,4,6-Trichlorophenol	11	U	200	R	20	U	400	R	10	U
2,4,5-Trichlorophenol	54	U	1000	R	100	U	2000	R	50	U
2-Chloronaphthalene	11	U	200	U	20	U	400	U	10	U
2-Nitroaniline	54	UJ	1000	U	100	U	2000	UJ	50	U
Dimethyl Phthalate	11	U	200	U	20	U	400	U	10	U
Acenaphthylene	11	U	200	U	20	U	400	UJ	10	U
2,6-Dinitrotoluene	11	U	200	U	20	U	400	UJ	10	U
3-Nitroaniline	54	R	1000	U	100	U	2000	UJ	50	U

AK300350

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Cont'd.)	CW-1I		CW-2I		CW-3I		CW-4I		CW-5I	
Acenaphthene	11	U	200	U	20	U	400	U	2	J
2,4-Dinitrophenol	54	UJ	1000	R	100	UJ	2000	R	50	U
4-Nitrophenol	54	UJ	1000	R	100	UJ	2000	R	50	U
Dibenzofuran	11	U	200	U	20	U	400	U	1	J
2,4-Dinitrotoluene	11	U	200	U	20	U	400	UJ	10	U
Diethylphthalate	11	U	200	U	20	U	400	U	10	U
4-Chlorophenyl-phenylether	11	U	200	U	20	U	400	UJ	10	UJ
Fluorene	11	U	200	U	20	U	400	UJ	4	J
4-Nitroaniline	54	UJ	1000	U	100	U	2000	UJ	50	U
4,6-Dinitro-2-Methylphenol	54	UJ	1000	R	100	U	2000	UJ	50	U
N-Nitrosodiphenylamine (1)	11	U	200	U	20	U	400	U	10	U
4-Bromophenyl-phenylether	11	U	200	U	20	U	400	U	10	U
Hexachlorobenzene	11	U	200	U	20	U	400	U	10	U
Pentachlorophenol	54	J	3000	J	100	U	3400	L	140	
Phenanthrene	11	U	200	U	20	U	400	U	5	J
Anthracene	0.5	U	200	U	20	U	400	U	10	U
Di-n-Butylphthalate	0.5	B	200	U	20	U	400	U	10	U
Fluoranthene	11	U	200	U	20	U	400	U	10	U
Pyrene	11	U	200	U	20	UJ	400	U	10	U
Butylbenzylphthalate	11	U	200	U	20	UJ	400	U	10	U
3,3-Dichlorobenzidine	22	UJ	400	U	40	UJ	800	R	20	U
Benzo(a)Anthracene	11	U	200	U	20	U	400	U	10	U
Chrysene	11	U	200	U	20	U	400	U	10	U
bis(2-Ethylhexyl)Phthalate	9	B	200	U	17	B	400	U	8	B
Di-n-Octyl Phthalate	11	U	200	U	20	U	400	U	10	U
Benzo(b)Fluoranthene	11	U	200	U	20	U	400	U	10	U
Benzo(k)Fluoranthene	11	UJ	200	U	20	U	400	UJ	10	UJ
Benzo(a)Pyrene	11	U	200	U	20	U	400	U	10	U
Indenol(1,2,3-cd)Pyrene	11	UJ	200	U	20	UJ	400	U	10	U
Dibenz(a,h)Anthracene	11	UJ	200	U	20	UJ	400	UJ	10	U
Benzo(g,h,i)Perylene	11	UJ	200	U	20	UJ	400	UJ	10	U

AR300951

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212

RI REPORT

REV. #1

21/JUN/91

SEMI-VOLATILE ORGANICS	CW-6I		CW-6I-DUP		CW-11-DUP		R-2		R-4	
Phenol	200	R	400	R	11	U	1500	R	20	UL
bis(2-Chloroethyl)Ether	200	U	400	UL	11	U	1500	R	20	UL
2-Chlorophenol	200	R	400	R	11	U	1500	R	20	UL
1,3-Dichlorobenzene	200	U	400	UL	11	U	1500	R	20	UL
1,4-Dichlorobenzene	200	U	400	UL	11	U	1500	R	20	UL
Benzyl Alcohol	200	R	400	R	11	U	1500	R	20	UL
1,2-Dichlorobenzene	200	U	400	UL	11	U	1500	R	20	UL
2-Methylphenol	200	R	400	R	11	U	1500	R	20	UL
bis(2-Chloroisopropyl)Ether	200		400	UL	11	U	1500	R	20	UL
4-Methylphenol	200	R	400	R	11	U	1500	R	20	UL
N-Nitroso-Di-n-Propylamine	200	U	400	UL	11	U	1500	R	20	UL
Hexachloroethane	200	U	400	UL	11	U	1500	R	20	UL
Nitrobenzene	200	U	400	UL	11	UJ	1500	R	20	UL
Isophorone	200	U	400	UL	11	U	1500	R	20	UL
2-Nitrophenol	200	R	400	R	11	U	1500	R	20	UL
2,4-Dimethylphenol	200	R	400	R	11	U	1500	R	20	UL
Benzoic Acid	1000	R	2000	R	54	U	7600	R	100	UL
bis(2-Chloroethoxy)Methane	200	UJ	400	UL	11	U	1500	R	20	UL
2,4-Dichlorophenol	200	R	400	R	11	U	1500	R	20	UL
1,2,4-Trichlorobenzene	200	U	400	UL	11	U	1500	R	20	UL
Naphthalene	180	J	160	L	11	U	24000	J	20	UL
4-Chloroaniline	200	U	400	UL	11	UJ	1500	R	20	UL
Hexachlorobutadiene	200	U	400	UL	11	U	1500	R	20	UL
4-Chloro-3-Methylphenol	200	R	400	R	11	U	1500	R	20	UL
2-Methylnaphthalene	47	J	35	L	11	U	21000	J	20	UL
Hexachlorocyclopentadiene	200	U	400	UL	11	U	1500	R	20	UL
2,4,6-Trichlorophenol	200	R	400	R	11	U	1500	R	20	UL
2,4,5-Trichlorophenol	1000	R	2000	R	54	U	7600	R	100	UL
2-Chloronaphthalene	200	U	400	UL	11	U	1500	R	20	UL
2-Nitroaniline	1000	UJ	2000	UL	54	UJ	7600	R	100	UL
Dimethyl Phthalate	200	U	400	UL	11	U	1500	R	20	UL
Acenaphthylene	200	UJ	400	UL	11	U	1500	R	20	UL
2,6-Dinitrotoluene	200	UJ	400	UL	11	U	1500	R	20	UL
3-Nitroaniline	1000	UJ	2000	UL	54	R	7600	R	100	UL

HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS
 µg/L
NOVEMBER, 1990

TCN 4212
 RI REPORT
 REV. #1
 21/JUN/91

SEMI-VOLATILE ORGANICS (Cont'd.)	CW-6I		CW-6I-DUP		CW-11-DUP		R-2		R-4	
Acenaphthene	200	U	400	UL	11	U	1700	J	20	UL
2,4-Dinitrophenol	1000	R	2000	R	54	UJ	7600	R	100	UL
4-Nitrophenol	1000	R	2000	R	54	UJ	7600	R	100	UL
Dibenzofuran	200	U	400	UL	11	UL	1300	J	20	UL
2,4-Dinitrotoluene	200	U	400	UL	11	U	1500	R	20	UL
Diethylphthalate	200	UJ	400	UL	11	U	1500	R	20	UL
4-Chlorophenyl-phenylether	200	UJ	400	UL	11	U	1500	R	20	UL
Fluorene	200	UJ	400	UL	11	U	2900	J	20	UL
4-Nitroaniline	1000	UJ	2000	UL	54	UJ	7600	R	100	UL
4,6-Dinitro-2-Methylphenol	1000	R	2000	R	54	UJ	7600	R	100	UL
N-Nitrosodiphenylamine (1)	200	U	400	UL	11	U	1500	R	20	UL
4-Bromophenyl-phenylether	200	U	400	UL	11	U	1500	R	20	UL
Hexachlorobenzene	200	U	400	UL	11	U	1500	R	20	UL
Pentachlorophenol	3000	L	3500	L	55		80000	J	100	UL
Phenanthrene	4	J	400	UL	11	U	12000	J	20	UL
Anthracene	200	U	400	UL	0.3	J	1900	J	20	UL
Di-n-Butylphthalate	200	U	400	UL	0.5	B	1500	R	20	UL
Fluoranthene	200	U	400	UL	11	U	810	J	20	UL
Pyrene	200	U	400	UL	11	U	1300	J	20	UL
Butylbenzylphthalate	200	U	400	UL	11	U	1500	R	20	UL
3,4-Dichlorobenzidine	400	R	800	R	22	UJ	3100	R	40	UL
Benzo(a)Anthracene	200	U	400	UL	11	U	190	J	20	UL
Pyrene	200	U	400	UL	11	U	240	J	20	UL
Di-n-Ethylhexyl)Phthalate	21	B	180	L	66		1500	R	8	B
Di-n-Octyl Phthalate	200	U	400	UL	11	U	1500	R	20	UL
Benzo(b)Fluoranthene	200	U	400	UL	11	U	1500	R	20	UL
Benzo(k)Fluoranthene	200	UJ	400	UL	11	UJ	1500	R	20	UL
Benzo(a)Pyrene	200	U	400	UL	11	U	1500	R	20	UL
Indenol(1,2,3-cd)Pyrene	200	U	400	UL	11	UJ	1500	R	20	UL
Dibenz(a,h)Anthracene	200	U	400	UL	11	UJ	1500	R	20	UL
Benzo(g,h,i)Perylene	200	U	400	UL	11	UJ	1500	R	20	UL

AR300953

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	NW-1		NW-3		NW-6	
Phenol	100	U	21	U	230	R
bis(2-Chloroethyl)Ether	100	UJ	21	U	230	U
2-Chlorophenol	100	U	21	U	230	R
1,3-Dichlorobenzene	100	U	21	U	230	U
1,4-Dichlorobenzene	100	U	21	U	230	U
Benzyl Alcohol	100	UJ	21	U	230	R
1,2-Dichlorobenzene	100	U	21	U	230	U
2-Methylphenol	100	U	21	U	230	B
bis(2-Chloroisopropyl)Ether	100	U	21	U	230	UJ
4-Methylphenol	100	U	21	U	230	R
N-Nitroso-Di-n-Propylamine	100	U	21	U	230	UJ
Hexachloroethane	100	U	21	U	230	U
Nitrobenzene	100	U	21	UJ	230	U
Isophorone	100	U	21	U	230	UJ
2-Nitrophenol	100	U	21	U	230	R
2,4-Dimethylphenol	100	U	21	U	230	R
Benzoic Acid	500	U	110	U	1100	R
bis(2-Chloroethoxy)Methane	100	U	21	U	230	U
2,4-Dichlorophenol	100	U	21	U	230	R
1,2,4-Trichlorobenzene	100	U	21	U	230	U
Naphthalene	1500		25		230	U
4-Chloroaniline	100	U	21	UJ	230	R
Hexachlorobutadiene	100	U	21	U	230	U
4-Chloro-3-Methylphenol	100	U	21	U	230	R
2-Methylnaphthalene	840		7	J	230	U
Hexachlorocyclopentadiene	100	UJ	21	U	230	UJ
2,4,6-Trichlorophenol	100	U	21	U	230	R
2,4,5-Trichlorophenol	500	U	110	U	1100	R
2-Chloronaphthalene	100	U	21	U	230	U
2-Nitroaniline	500	U	110	UJ	1100	U
Dimethyl Phthalate	100	U	21	U	230	U
Acenaphthylene	16	J	21	U	230	U
2,6-Dinitrotoluene	100	U	21	U	230	U
3-Nitroaniline	500	U	110	R	1100	R

AR 500954

HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS
 µg/L
NOVEMBER, 1990

TCN 4212
 RI REPORT
 REV. #1
 21/JUN/91

SEMI-VOLATILE ORGANICS (Cont'd.)	NW-1		NW-3		NW-6	
Acenaphthene	180		110	U	230	U
2,4-Dinitrophenol	500	UJ	21	UJ	1100	R
4-Nitrophenol	500	UJ	110	UJ	1100	R
Dibenzofuran	70	J	110	U	230	U
2,4-Dinitrotoluene	100	U	21	U	230	U
Diethylphthalate	100	U	21	U	230	U
4-Chlorophenyl-phenylether	100	U	21	U	230	U
Fluorene	340		21	U	230	U
4-Nitroaniline	500	U	21	UJ	1100	U
4,6-Dinitro-2-Methylphenol	500	U	110	UJ	1100	R
N-Nitrosodiphenylamine (1)	100	U	110	U	230	U
4-Bromophenyl-phenylether	100	U	21	U	230	U
Hexachlorobenzene	100	U	21	U	230	U
Pentachlorophenol	500	U	21	U	2800	J
Phenanthrene	1000		180		230	U
Anthracene	220		21	U	230	U
Di-n-Butylphthalate	100	U	21	U	230	U
Fluoranthene	100		21	U	230	U
Pyrene	200		21	U	230	U
Butylbenzylphthalate	100	UJ	21	U	230	UJ
3,3-Dichlorobenzidine	200	UJ	21	UJ	450	R
Benzo(a)Anthracene	25	J	43	U	230	U
Chrysene	100	U	21	U	230	U
bis(2-Ethylhexyl)Phthalate	100	U	21	U	230	UJ
Di-n-Octyl Phthalate	100	U	21	U	230	U
Benzo(b)Fluoranthene	100	U	21	U	230	U
Benzo(k)Fluoranthene	100	UJ	21	UJ	230	UJ
Benzo(a)Pyrene	100	U	21	U	230	U
Indenol(1,2,3-cd)Pyrene	100	UJ	21	UJ	230	UJ
Dibenz(a,h)Anthracene	100	UJ	21	UJ	230	U
Benzo(g,h,i)Perylene	100	UJ	21	UJ	230	UJ

AR300955

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RJ REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	CW-1D		CW-2D		CW-3D		CW-4D		CW-5D	
Phenol	12	U	250	R	100	R	400	R	10	R
bis(2-Chloroethyl)Ether	12	U	250	U	100	U	400	UL	10	U
2-Chlorophenol	12	U	250	R	100	R	400	R	10	R
1,3-Dichlorobenzene	12	U	250	U	100	U	400	UL	10	U
1,4-Dichlorobenzene	12	U	250	U	100	U	400	UL	10	U
Benzyl Alcohol	12	U	250	R	100	R	400	R	10	R
1,2-Dichlorobenzene	12	U	250	U	100	U	400	UL	10	U
2-Methylphenol	12	U	250	R	100	R	400	R	10	R
bis(2-Chloroisopropyl)Ether	12	U	250	U	100	U	400	UL	10	U
4-Methylphenol	12	U	250	R	100	R	400	R	10	R
N-Nitroso-Di-n-Propylamine	12	U	250	U	100	U	400	UL	10	U
Hexachloroethane	12	U	250	U	100	U	400	UL	10	U
Nitrobenzene	12	UJ	250	U	100	U	400	UL	10	U
Isophorone	12	U	250	U	100	U	400	UL	10	U
2-Nitrophenol	12	U	250	R	100	R	400	R	10	R
2,4-Dimethylphenol	12	U	250	R	100	R	400	R	10	R
Benzoic Acid	60	U	1200	R	500	R	2000	R	50	R
bis(2-Chloroethoxy)Methane	12	U	250	U	100	U	400	UL	10	U
2,4-Dichlorophenol	12	U	250	R	100	R	400	R	10	R
1,2,4-Trichlorobenzene	12	U	250	U	100	U	400	UL	10	U
Naphthalene	12	U	220	J	100	U	140	JL	12	
4-Chloroaniline	12	UJ	250	U	100	U	400	UL	10	U
Hexachlorobutadiene	12	U	250	U	100	U	400	UL	10	U
4-Chloro-3-Methylphenol	12	U	250	R	100	R	400	R	10	R
2-Methylnaphthalene	12	U	44	J	100	U	40	L	33	
Hexachlorocyclopentadiene	12	U	250	U	100	U	400	UL	10	U
2,4,6-Trichlorophenol	12	U	250	R	100	R	400	R	10	R
2,4,5-Trichlorophenol	60	U	1200	R	500	R	2000	R	50	R
2-Chloronaphthalene	12	U	250	U	100	U	400	UL	10	U
2-Nitroaniline	60	UJ	1200	U	500	U	2000	UL	50	U
Dimethyl Phthalate	12	U	250	U	100	U	400	UL	10	U
Acenaphthylene	12	U	250	U	100	U	400	UL	10	U

AR300956

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Conf'd.)	CW-1D		CW-2D		CW-3D		CW-4D		CW-5D	
Acenaphthene	12	U	250	U	100	U	400	UL	2	J
2,4-Dinitrophenol	60	UJ	1200	R	500	R	2000	R	50	R
4-Nitrophenol	60	UJ	1200	R	500	R	2000	R	50	R
Dibenzofuran	12	U	250	U	100	U	400	UL	0.8	J
2,4-Dinitrotoluene	12	U	250	U	100	U	400	UL	10	U
Diethylphthalate	12	U	250	U	100	U	400	UL	10	UJ
4-Chlorophenyl-phenylether	12	U	250	U	100	U	400	UL	10	U
Fluorene	12	U	250	U	100	U	400	UL	2	J
4-Nitroaniline	60	UJ	1200	U	500	U	2000	UL	50	UJ
4,6-Dinitro-2-Methylphenol	60	UJ	1200	R	500	R	2000	R	50	R
N-Nitrosodiphenylamine (1)	12	U	250	U	100	U	400	UL	10	U
4-Bromophenyl-phenylether	12	U	250	U	100	U	400	UL	10	U
Hexachlorobenzene	12	U	250	U	100	U	400	UL	10	U
Pentachlorophenol	57	J	3300	J	560	L	3700	L	75	L
Phenanthrene	12	U	250	U	100	U	400	UL	3	J
Anthracene	12	U	250	U	100	U	400	UL	10	U
Di-n-Butylphthalate	1	B	250	U	100	U	400	UL	10	U
Fluoranthene	12	U	250	U	100	U	400	UL	10	U
Pyrene	12	U	250	U	100	U	400	UL	10	U
Butylbenzylphthalate	12	U	250	U	100	U	400	UL	10	U
3,3-Dichlorobenzidine	24	UJ	500	U	200	U	800	R	20	UJ
Benzo(a)Anthracene	12	U	250	U	100	U	400	UL	10	U
Chrysene	12	U	250	U	100	U	400	UL	10	U
bis(2-Ethylhexyl)Phthalate	18	B	250	U	100	U	400	UL	6	B
Di-n-Octyl Phthalate	12	U	250	U	100	U	400	UL	10	U
Benzo(b)Fluoranthene	12	U	250	U	100	U	400	UL	10	U
Benzo(k)Fluoranthene	12	UJ	250	U	100	UJ	400	UL	10	UJ
Benzo(a)Pyrene	12	U	250	U	100	U	400	UL	10	U
Indenol(1,2,3-cd)Pyrene	12	UJ	250	U	100	U	400	UL	10	U
Dibenz(a,h)Anthracene	12	UJ	250	U	100	U	400	UL	10	U
Benzo(g,h,i)Perylene	12	UJ	250	U	100	U	400	UL	10	U

AR300957

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS	CW-6D	
Phenol	400	R
bis(2-Chloroethyl)Ether	400	U
2-Chlorophenol	400	R
1,3-Dichlorobenzene	400	U
1,4-Dichlorobenzene	400	U
Benzyl Alcohol	400	R
1,2-Dichlorobenzene	400	U
2-Methylphenol	400	R
bis(2-Chloroisopropyl)Ether	400	U
4-Methylphenol	400	R
N-Nitroso-Di-n-Propylamine	400	U
Hexachloroethane	400	U
Nitrobenzene	400	U
Isophorone	400	U
2-Nitrophenol	400	R
2,4-Dimethylphenol	400	R
Benzoic Acid	2000	R
bis(2-Chloroethoxy)Methane	400	UJ
2,4-Dichlorophenol	400	R
1,2,4-Trichlorobenzene	400	U
Naphthalene	400	
4-Chloroaniline	400	U
Hexachlorobutadiene	400	U
4-Chloro-3-Methylphenol	400	R
2-Methylnaphthalene	65	J
Hexachlorocyclopentadiene	400	U
2,4,6-Trichlorophenol	400	R
2,4,5-Trichlorophenol	2000	R
2-Chloronaphthalene	400	U
2-Nitroaniline	2000	UJ
Dimethyl Phthalate	400	UJ
Acenaphthylene	400	UJ
2,6-Dinitrotoluene	400	UJ
3-Nitroaniline	2000	UJ

AR300958

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

SEMI-VOLATILE ORGANICS (Cont'd.)	CW-6D	
Acenaphthene	400	U
2,4-Dinitrophenol	2000	R
4-Nitrophenol	2000	R
Dibenzofuran	400	U
2,4-Dinitrotoluene	400	UJ
Diethylphthalate	400	U
4-Chlorophenyl-phenylether	400	UJ
Fluorene	400	UJ
4-Nitroaniline	2000	UJ
4,6-Dinitro-2-Methylphenol	2000	R
N-Nitrosodiphenylamine (1)	400	U
4-Bromophenyl-phenylether	400	U
Hexachlorobenzene	400	U
Pentachlorophenol	3500	L
Phenanthrene	400	U
Anthracene	400	U
Di-n-Butylphthalate	400	U
Fluoranthene	400	U
Pyrene	400	U
Butylbenzylphthalate	400	U
3,3-Dichlorobenzidine	800	R
Benzo(a)Anthracene	400	U
Chrysene	400	U
bis(2-Ethylhexyl)Phthalate	400	U
Di-n-Octyl Phthalate	400	U
Benzo(b)Fluoranthene	400	U
Benzo(k)Fluoranthene	400	UJ
Benzo(a)Pyrene	400	U
Indenol(1,2,3-cd)Pyrene	40	U
Dibenz(a,h)Anthracene	400	UJ
Benzo(g,h,i)Perylene	400	UJ

AR300959

APPENDIX B-3
PESTICIDES AND PCB'S
IN GROUND WATER - 1990

AR300960

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

µg/L
NOVEMBER, 1990

TCN 4212

RI REPORT

REV. #1

21/JUN/91

PESTICIDES	CW-1S		CW-2S		CW-3S		CW-4S		CW-5S	
alpha-BHC	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
beta-BHC	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
delta-BHC	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
gamma-BHC (Lindane)	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
Heptachlor	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
Aldrin	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
Heptachlor epoxide	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
Endosulfan I	.062	U	0.5	U	0.1	U	0.5	U	0.1	U
Dieldrin	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
4,4'-DDE	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
Endrin	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
Endosulfan II	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
4,4'-DDD	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
Endosulfan sulfate	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
4,4'-DDT	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
Methoxychlor	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Endrin ketone	.12	U	1.0	U	0.2	U	1.0	U	0.2	U
alpha-Chlordane	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
gamma-Chlordane	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Toxaphene	1.2	U	10	U	2.0	U	10	U	2.0	U
Aroclor-1016	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Aroclor-1221	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Aroclor-1232	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Aroclor-1242	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Aroclor-1248	.62	U	5.0	U	1.0	U	5.0	U	1.0	U
Aroclor-1254	1.2	U	10	U	2.0	U	10	U	2.0	U
Aroclor-1260	1.2	U	10	U	2.0	U	10	U	2.0	U

AR300961

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

PESTICIDES	CW-6S		HAV-02		HAV-04		HAV-05		HAV-07	
alpha-BHC	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
beta-BHC	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
delta-BHC	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
gamma-BHC (Lindane)	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
Heptachlor	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
Aldrin	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
Heptachlor epoxide	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
Endosulfan I	0.05	U	.62	U	0.25	U	0.5	U	0.05	U
Dieldrin	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
4,4'-DDE	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
Endrin	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
Endosulfan II	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
4,4'-DDD	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
Endosulfan sulfate	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
4,4'-DDT	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
Methoxychlor	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Endrin ketone	0.1	U	1.2	U	0.5	U	1.0	U	0.1	U
alpha-Chlordane	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
gamma-Chlordane	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Toxaphene	1.0	U	12	U	5.0	U	10	U	1.0	U
Aroclor-1016	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Aroclor-1221	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Aroclor-1232	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Aroclor-1242	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Aroclor-1248	0.5	U	6.2	U	2.5	U	5.0	U	0.5	U
Aroclor-1254	1.0	U	12	U	5.0	U	10	U	1.0	U
Aroclor-1260	1.0	U	12	U	5.0	U	10	U	1.0	U

AR300962

HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS

µg/L
NOVEMBER, 1990

TCN 4212
R1 REPORT
REV. #1
21/JUN/91

PESTICIDES	HAV-08	
alpha-BHC	0.05	U
beta-BHC	0.05	U
delta-BHC	0.05	U
gamma-BHC (Lindane)	0.05	U
Heptachlor	0.05	U
Aldrin	0.05	U
Heptachlor epoxide	0.05	U
Endosulfan I	0.05	U
Dieldrin	0.1	U
4,4'-DDE	0.1	U
Endrin	0.1	U
Endosulfan II	0.1	U
4,4'-DDD	0.1	U
Endosulfan sulfate	0.1	U
4,4'-DDT	0.1	U
Methoxychlor	0.5	U
Endrin ketone	0.1	U
alpha-Chlordane	0.5	U
gamma-Chlordane	0.5	U
Toxaphene	1.0	U
Aroclor-1016	0.5	U
Aroclor-1221	0.5	U
Aroclor-1232	0.5	U
Aroclor-1242	0.5	U
Aroclor-1248	0.5	U
Aroclor-1254	1.0	U
Aroclor-1260	1.0	U

AR300963

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

PESTICIDES	CW-1I		CW-2I		CW-3I		CW-4I		CW-5I	
alpha-BHC	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
beta-BHC	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
delta-BHC	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
gamma-BHC (Lindane)	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
Heptachlor	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
Aldrin	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
Heptachlor epoxide	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
Endosulfan I	.062	U	0.25	U	0.1	U	0.25	U	0.5	U
Dieldrin	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
4,4'-DDE	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
Endrin	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
Endosulfan II	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
4,4'-DDD	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
Endosulfan sulfate	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
4,4'-DDT	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
Methoxychlor	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Endrin ketone	.12	U	0.5	U	0.2	U	0.5	U	1.0	U
alpha-Chlordane	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
gamma-Chlordane	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Toxaphene	1.2	U	5.0	U	2.0	U	5.0	U	10	U
Aroclor-1016	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Aroclor-1221	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Aroclor-1232	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Aroclor-1242	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Aroclor-1248	.62	U	2.5	U	1.0	U	2.5	U	5.0	U
Aroclor-1254	1.2	U	5.0	U	2.0	U	5.0	U	10	U
Aroclor-1260	1.2	U	5.0	U	2.0	U	5.0	U	10	U

AR300964

HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS
 $\mu\text{g/L}$
NOVEMBER, 1990

TCN 4212
 RI REPORT
 REV. #1
 21/JUN/91

PESTICIDES	CW-6I		CW-6I-DUP		CW-11-DUP		R-2		R-4	
alpha-BHC	0.5	U	0.1	U	.062	U	.31	U	.062	U
beta-BHC	0.5	U	0.1	U	.062	U	.31	U	.062	U
delta-BHC	0.5	U	0.1	U	.062	U	.31	U	.062	U
gamma-BHC (Lindane)	0.5	U	0.1	U	.062	U	.31	U	.062	U
Heptachlor	0.5	U	0.1	U	.062	U	.31	U	.062	U
Aldrin	0.5	U	0.1	U	.062	U	.31	U	.062	U
Heptachlor epoxide	0.5	U	0.1	U	.062	U	.31	U	.062	U
Endosulfan I	0.5	U	0.1	U	.062	U	.31	U	.062	U
Dieldrin	1.0	U	0.2	U	.12		.62	U	.61	
4,4'-DDE	1.0	U	0.2	U	.12	U	.62	U	.12	U
Endrin	1.0	U	0.2	U	.12	U	.62	U	.12	U
Endosulfan II	1.0	U	0.2	U	.12	U	3.5		.12	U
4,4'-DDD	1.0	U	0.2	U	.12	U	.62	U	.12	U
Endosulfan sulfate	1.0	U	0.2	U	.12	U	.62	U	.12	U
4,4'-DDT	1.0	U	0.2	U	.12	U	.62	U	.12	U
Methoxychlor	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Endrin ketone	1.0	U	0.2	U	.12	U	.62	U	.12	U
alpha-Chlordane	5.0	U	1.0	U	.62	U	3.1	U	.62	U
gamma-Chlordane	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Toxaphene	10	U	2.0	U	1.2	U	6.2	U	1.2	U
Aroclor-1016	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Aroclor-1221	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Aroclor-1232	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Aroclor-1242	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Aroclor-1248	5.0	U	1.0	U	.62	U	3.1	U	.62	U
Aroclor-1254	10	U	2.0	U	1.2	U	6.2	U	1.2	U
Aroclor-1260	10	U	2.0	U	1.2	U	6.2	U	1.2	U

AR300965

HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS
 µg/L
 NOVEMBER, 1990

TCN 4212
 RI REPORT
 REV. #1
 21/JUN/91

PESTICIDES	NW-1		NW-3		NW-6	
alpha-BHC	0.5	U	.054	U	.062	U
beta-BHC	0.5	U	.054	U	.062	U
delta-BHC	0.5	U	.054	U	.062	U
gamma-BHC (Lindane)	0.5	U	.054	U	.062	U
Heptachlor	0.5	U	.054	U	.062	U
Aldrin	0.5	U	.054	U	.062	U
Heptachlor epoxide	0.5	U	.054	U	.062	U
Endosulfan I	0.5	U	.054	U	.062	U
Dieldrin	1.0	U	.11	U	.12	U
4,4'-DDE	1.0	U	.11	U	.12	U
Endrin	1.0	U	.11	U	.12	U
Endosulfan II	1.0	U	.11	U	.12	U
4,4'-DDD	1.0	U	.11	U	.12	U
Endosulfan sulfate	1.0	U	.11	U	.12	U
4,4'-DDT	1.0	U	.11	U	.12	U
Methoxychlor	5.0	U	.54	U	.62	U
Endrin ketone	1.0	U	.11	U	.12	U
alpha-Chlordane	5.0	U	.54	U	.62	U
gamma-Chlordane	5.0	U	.54	U	.62	U
Toxaphene	10	U	1.1	U	1.2	U
Aroclor-1016	5.0	U	.54	U	.62	U
Aroclor-1221	5.0	U	.54	U	.62	U
Aroclor-1232	5.0	U	.54	U	.62	U
Aroclor-1242	5.0	U	.54	U	.62	U
Aroclor-1248	5.0	U	.54	U	.62	U
Aroclor-1254	10	U	1.1	U	1.2	U
Aroclor-1260	10	U	1.1	U	1.2	U

AR300966

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

PESTICIDES	CW-1D		CW-2D		CW-3D		CW-4D		CW-5D	
alpha-BHC	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
beta-BHC	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
delta-BHC	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
gamma-BHC (Lindane)	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
Heptachlor	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
Aldrin	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
Heptachlor epoxide	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
Endosulfan I	.062	U	0.25	U	0.1	U	0.1	U	0.1	U
Dieldrin	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
4,4'-DDE	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
Endrin	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
Endosulfan II	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
4,4'-DDD	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
Endosulfan sulfate	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
4,4'-DDT	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
Methoxychlor	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Endrin ketone	.12	U	0.5	U	0.2	U	0.2	U	0.2	U
alpha-Chlordane	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
gamma-Chlordane	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Toxaphene	1.2	U	5.0	U	2.0	U	2.0	U	2.0	U
Aroclor-1016	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Aroclor-1221	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Aroclor-1232	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Aroclor-1242	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Aroclor-1248	.62	U	2.5	U	1.0	U	1.0	U	1.0	U
Aroclor-1254	1.2	U	5.0	U	2.0	U	2.0	U	2.0	U
Aroclor-1260	1.2	U	5.0	U	2.0	U	2.0	U	2.0	U

AR300967

HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

PESTICIDES	CW-6D	
alpha-BHC	0.5	U
beta-BHC	0.5	U
delta-BHC	0.5	U
gamma-BHC (Lindane)	0.5	U
Heptachlor	0.5	U
Aldrin	0.5	U
Heptachlor epoxide	0.5	U
Endosulfan I	0.5	U
Dieldrin	1.0	U
4,4'-DDE	1.0	U
Endrin	1.0	U
Endosulfan II	1.0	U
4,4'-DDD	1.0	U
Endosulfan sulfate	1.0	U
4,4'-DDT	1.0	U
Methoxychlor	5.0	U
Endrin ketone	1.0	U
alpha-Chlordane	5.0	U
gamma-Chlordane	5.0	U
Toxaphene	10	U
Aroclor-1016	5.0	U
Aroclor-1221	5.0	U
Aroclor-1232	5.0	U
Aroclor-1242	5.0	U
Aroclor-1248	5.0	U
Aroclor-1254	10	U
Aroclor-1260	10	U

AR300968

APPENDIX B-4
INORGANIC COMPOUND DATA
IN GROUND WATER - 1990

AR300969

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	CW-1S		CW-2S		CW-3S		CW-4S		CW-5S	
Aluminum	26	U	234		26	U	26	U	42.8	P
Antimony	24	U	24	U	24	U	24	U	24	U
Arsenic	2	U	2	U	2	U	2	U	28	
Barium	21.8	P	43.8	B	77.2	P	44.9	P	107	P
Beryllium	1	U	1	U	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U	3	U	3	U
Calcium	85600		30100		21700		21600		15300	
Chromium	6	U	6	U	6	U	6	U	6	U
Cobalt	206		270		21.7	P	13.2	P	16.2	P
Copper	3	U	6.5	P	3	U	3.9	B	3	U
Iron	27900		322		10800		35	P	16200	
Lead	1	UL	1	UL	2	U	2.8	PB	2.4	PB
Magnesium	21900		11600		7980		13000		8700	
Manganese	9960		8350		6620		4840		6600	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	6	UJ	6	UJ	6	U	6	U	6	U
Potassium	7100		3500	P	5530	L	4760	PL	4550	PL
Selenium	3	U	3	U	3	UL	3	UL	3	UL
Silver	5	U	5	U	5	U	5	U	5	U
Sodium	38800	L	15300	L	63500		26200	L	9190	L
Thallium	3	U	3	U	10	UL	2	UL	2	UL
Vanadium	3	U	3	U	3	U	3	U	3	U
Zinc	32.4	B	54.2	B	14.2	B	36.3	B	26	B
Cyanide	10	U	10	U	10	U	10	U	10	U

AR300970

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	CW-6S		HAV-02		HAV-04		HAV-05		HAV-07	
Aluminum	48.5	P	26	U	35.1	P	55.6	P	61.1	P
Antimony	24	U	24	U	24	U	24	U	24	U
Arsenic	2.8	P	8	P	2	U	2	U	2.7	P
Barium	357		184	P	31.5	P	115	P	94.3	P
Beryllium	1	U	1	U	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U	3	U	3	U
Calcium	110000		32100		20900		15700		30000	
Chromium	6	U	6	U	6	U	6	U	6	U
Cobalt	4	U	146		179		65.5		8.5	P
Copper	3	U	3	U	3	U	3	U	3	U
Iron	8170		6740		959		18600		1500	
Lead	4.8	B	1.1	PB	5.5	B	4.6	B	2.8	PB
Magnesium	81600		23200		14300		8660		11100	
Manganese	3610		19200		22600		9630		951	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	6	U	20.9	PJ	14.8	P	6	U	6	U
Potassium	22000	L	8430		4280	PL	4840	B	6100	L
Selenium	3	U	3	U	3	UL	3	UL	3	UL
Silver	5	U	5	U	5	U	5	U	5	U
Sodium	137000		48600	L	26600	L	13400	L	13000	L
Thallium	10	UL	3	U	2	UL	2	UL	2	U
Vanadium	3	U	3	U	3	U	3	U	3	UL
Zinc	15.7	PB	72.5	B	26		40	B	34.4	B
Cyanide	10	U	10	U	10	U	10	U	10	U

AR300971

**HAVERTOWN PCP SITE
GROUND WATER - SHALLOW WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	HAV-08	
Aluminum	38.4	P
Antimony	24	U
Arsenic	2	U
Barium	229	
Beryllium	1	U
Cadmium	3	U
Calcium	42600	
Chromium	6	U
Cobalt	41.7	P
Copper	3	U
Iron	20	U
Lead	2	U
Magnesium	23600	
Manganese	3350	
Mercury	0.2	U
Nickel	6.5	P
Potassium	5150	L
Selenium	3	UL
Silver	5	U
Sodium	27800	L
Thallium	2	UL
Vanadium	3	U
Zinc	135	
Cyanide	10	U

AR300972

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

μg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	CW-1I		CW-2I		CW-3I		CW-4I		CW-5I	
Aluminum	26	U	142	P	40.2	P	26	U	26	U
Antimony	24	U	24	U	24	U	24	U	24	U
Arsenic	2	U	2.3	P	2	U	14.8		3.1	L
Barium	25.2	P	21	P	128	P	63.7	P	275	
Beryllium	1	U	1	U	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U	3.4	P	3	U
Calcium	58700		26600		22400		28000		16400	
Chromium	6	U	6	U	6	U	6	U	6	U
Cobalt	109		226		34	P	92		8.9	P
Copper	3	U	3	U	3	U	3	U	3	U
Iron	10200		134		6600		8810		27800	
Lead	1	UL	1	UL	4.8	B	8.7	B	3.3	B
Magnesium	18100		11100		8160		13900		10300	
Manganese	7910		6580		6860		9000		8700	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	6	UJ	6	UJ	6	U	21	P	6	U
Potassium	9720		3660	P	5440	L	6300	L	5800	L
Selenium	3	U	3	U	3	UL	3	UL	3	UL
Silver	5	U	5	U	5	U	5	U	5	U
Sodium	39600	L	15300	L	62300		29700	L	15100	L
Thallium	3	U	3	U	2	UL	2	UL	2	UL
Vanadium	3	U	3	U	3	U	3	U	3	U
Zinc	59	B	243		18.2	PB	44.7	B	31.8	B
Cyanide	10	U	10	U	10	U	10	U	10	U

AR300973

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

**µg/L
NOVEMBER, 1990**

TCN 4212
R1 REPORT
REV. #1
21/JUN/91

INORGANICS	CW-6I		CW-6I-DUP		CW-1I-DUP		R-2		R-4	
Aluminum	26	U	26	U	26	U	26	U	45.8	PB
Antimony	24	U	24	U	24	U	24	U	24	U
Arsenic	2	U	2	U	2	U	22.7		2	U
Barium	35.1	P	36	P	25.4	P	37	P	103	P
Beryllium	1	U	1	U	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U	3	U	3	U
Calcium	60300		63300		58400		53300		13400	
Chromium	6	U	6	U	6	U	6	U	6	U
Cobalt	41.8	P	41.4	P	111		91.7		4	U
Copper	3	U	3	U	3	U	3	U	3	U
Iron	521		506		31500		23600		31.7	P
Lead	2	U	2	U	1	UL	1	UL	1	UL
Magnesium	21300		22200		18100		20200		11800	
Manganese	5070		5350		8790		17300		28.5	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	26.9	P	23.4	P	6	UJ	6	UJ	6	UJ
Potassium	7000	L	7150	L	7070		12500		2370	P
Selenium	3	UL	3	UL	3	U	3	U	3	U
Silver	5	U	5	U	5	U	5	U	5	U
Sodium	36100	L	37400	L	37800	L	54500		9770	L
Thallium	10	UL	10	UL	3	U	3	U	3	U
Vanadium	3	U	3	U	4	P	3.4	P	3	U
Zinc	34.4	B	32	B	45.7	B	193		41.1	B
Cyanide	10	U	10	U	10	U	10	U	10	U

AR300974

**HAVERTOWN PCP SITE
GROUND WATER - INTERMEDIATE WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	NW-1		NW-3		NW-6	
Aluminum	26	U	147	B	26	U
Antimony	24	U	24	U	24	U
Arsenic	2	U	2	U	13.6	P
Barium	63.1	P	27	P	54.8	P
Beryllium	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U
Calcium	28200		95200		42200	
Chromium	6	U	21.6		6	U
Cobalt	9.5	P	97.7		89.6	
Copper	3	U	3	U	3	U
Iron	1830		41.9	P	11300	
Lead	1	UL	1	UL	1	UL
Magnesium	9120		27400		12900	
Manganese	561		4620		8800	
Mercury	0.2	U	0.2	U	0.2	U
Nickel	6	UJ	6	UJ	12.3	PJ
Potassium	3550	P	1390	P	6630	
Selenium	3	U	3	U	3	U
Silver	5	U	5	U	5	U
Sodium	19600	L	25000	L	21100	L
Thallium	4.2	P	3	U	3	U
Vanadium	3	U	3	U	3	U
Zinc	19.4	B	40.6	B	82.7	B
Cyanide	10	U	10	U	10	U

AR300975

**HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS**

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	CW-1D		CW-2D		CW-3D		CW-4D		CW-5D	
Aluminum	26	U	2390		26	U	31.4	P	26	U
Antimony	24	U	24	U	24	U	24	U	24	U
Arsenic	2	U	2	U	2	U	26.1		2	P
Barium	45.3	P	103	P	81.2	P	45.5	P	257	
Beryllium	1	U	1	U	1	U	1	U	1	U
Cadmium	3	U	3	U	3	U	3	U	3	U
Calcium	26300		41600		32500		23600		17200	
Chromium	6	U	6	U	6	U	6	U	6	U
Cobalt	10.7	P	413		30.2	P	69.3		6.4	P
Copper	3	U	13.6	P	3	U	3	U	3	U
Iron	30700		6570		3630		11100		31400	
Lead	2.2	PB	4.9	B	6.8	B	14.5	B	6.8	B
Magnesium	12000		16800		14600		13700		10900	
Manganese	3680		9350		5280		9120		8700	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	6	U	64.7	J	10.1	P	6	U	6	U
Potassium	5070		5910		10600	L	7160	L	4840	PL
Selenium	3	U	3	U	3	UL	3	UL	3	UL
Silver	5	U	5	U	5	U	5	U	5	U
Sodium	25900		18700		35600	L	29700	L	16500	L
Thallium	3	U	3	U	2	UL	2	UL	2	U
Vanadium	3	U	19.8	P	3	U	3	U	3	U
Zinc	61.9	P	102		59.1	B	86.8	B	34.3	B
Cyanide	10	U	10	U	10	U	10	U	10	U

AR300976

HAVERTOWN PCP SITE
GROUND WATER - DEEP WELLS

µg/L
NOVEMBER, 1990

TCN 4212
RI REPORT
REV. #1
21/JUN/91

INORGANICS	CW-6D	
Aluminum	26	U
Antimony	24	U
Arsenic	2	U
Barium	25.4	P
Beryllium	1	U
Cadmium	3	U
Calcium	54800	
Chromium	6	U
Cobalt	40.1	P
Copper	3	U
Iron	562	
Lead	3.9	B
Magnesium	22500	
Manganese	5870	
Mercury	0.2	U
Nickel	19.2	P
Potassium	7610	L
Selenium	3	UL
Silver	5	U
Sodium	45800	L
Thallium	10	UL
Vanadium	3	U
Zinc	40.9	
Cyanide	10	U

AR300977

APPENDIX B-5
DIOXIN DATA
IN GROUND WATER - 1990

AR300978

**HAVERTOWN PCP SITE
GROUND WATER - DIOXIN
AQUEOUS SAMPLES
NOVEMBER, 1990**

TCN 4212
RI REPORT
REV. #1
21/JUN/91

Sample Station	AQ-TriLab	TE PPT _r	Comments
CW-1S	DC-0457-07	0.000	
CW-2S	DC-0462-24	4.464	
CW-3S	DC-0462-20	0.001	
CW-4S	DC-0462-13	0.776	
CW-5S	DC-0462-08	0.012	
CW-6S	DC-0462-17	0.001	
HAV-02	DC-0457-11	23.136	
HAV-04	DC-0462-10	173.739	
HAV-05	DC-0462-09	3.599	
HAV-07	DC-0462-01	0.212	
HAV-08	DC-0462-02	0.052	
CW-1I	DC-0457-05	0.000	
	DC-0457-06	0.000	Field Dup of Station 1I
CW-2I	DC-0462-23	0.004	
CW-3I	DC-0462-19	0.001	
CW-4I	DC-0462-12	0.439	
CW-5I	DC-0462-07	0.084	
CW-6I	DC-0462-15	0.000	
	DC-0462-16	0.000	Field Dup of Station 6I
R-2	DC-0457-12	29.39	
R-4	DC-0457-09	0.007	
NW-1	DC-0462-21	9.976	
NW-3	DC-0457-01	0.032	
NW-6	DC-0457-08	0.008	
CW-1D	DC-0457-04	0.000	
CW-2D	DC-0462-22	0.004	
CW-3D	DC-0462-18	0.000	
CW-4D	DC-0462-11	0.084	
CW-5D	DC-0462-06	0.020	
CW-6D	DC-0462-14	0.012	
	DC-0457-03	0.001	Sample to Spike
	DC-0457-02	0.000	Field Blank
	DC-0457-10	1.807	Equipment Rinsate
	DC-0462-03	0.000	Field Blank
	DC-0462-04	0.000	Field Blank
	DC-0462-05	3.994	Equipment Rinsate

AR300979

EXAMPLE CALCULATION
OF
TOXICITY EQUIVALENT FOR 2,3,7,8-TCDD

Sample Location	D-4 (0-2')	Toxic Equivalency Factor 1-TEFs/88	Toxicity Equivalent (ug/kg)
Units	(ug/kg)		
Isomer			
2378-TCDD	0	1	0.0000
Other TCDD	0.21	0	0.0000
12378-PeCDD	0	0.5	0.0000
Other PeCDD	0.01	0	0.0000
123478-HxCDD*	0.06	0.1	0.0060
123678-HxCDD		0.1	0.0000
123789-HxCDD		0.1	0.0000
Other HxCDD	0.32	0	0.0000
1234678-HpCDD	0.440	0.01	0.0044
Other HpCDD	0.490	0	0.0000
CCDD	4.800	0.001	0.0048
2378-TCDF	0.01	0.1	0.0010
Other TCDF	0.22	0	0.0000
12378-PeCDF		0.05	0.0000
23478-PeCDF*	0.007	0.5	0.0035
Other PeCDF	0.028	0	0.0000
123478-HxCDF*	0.04	0.1	0.0040
123678-HxCDF		0.1	0.0000
234678-HxCDF		0.1	0.0000
123789-HxCDF		0.1	0.0000
Other HxCDF	0.04	0	0.0000
1234678-HpCDF*	0.09	0.01	0.0009
1234789-HpCDF		0.01	0.0000
Other HpCDF	0.01	0	0.0000
CCDF	0.21	0.001	0.0002
Total 2,3,7,8-TCDD Equivalent			0.0248

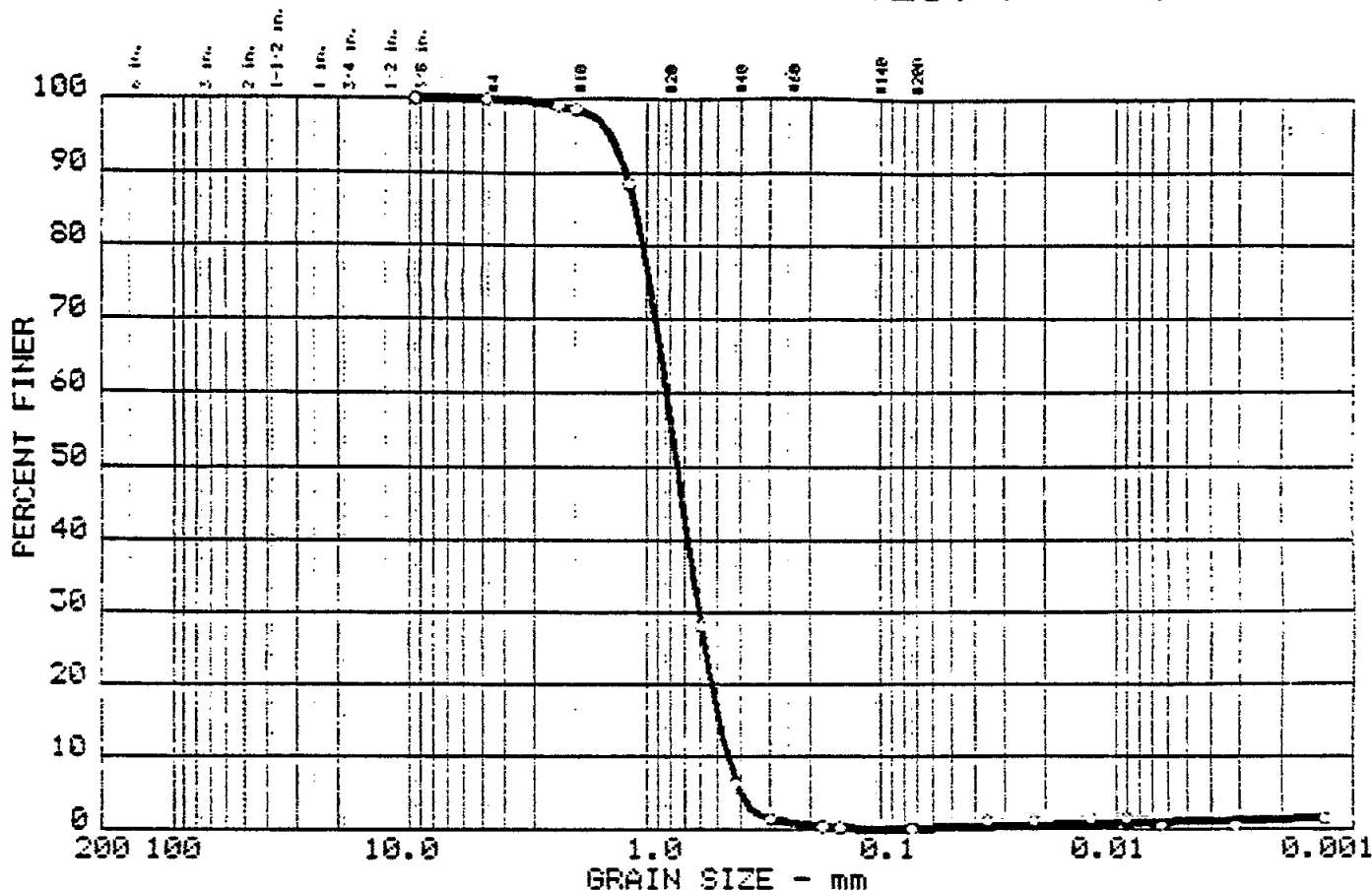
Note: All results are reported on a dry weight basis.

1-TEFs/88: International Toxic Equivalency Factors 1988.

*Where an isomer is not explicitly specified in the results, the related isomer with the maximum TEF is used in the equivalency calculation.

AR300980

GRAIN SIZE DISTRIBUTION TEST REPORT



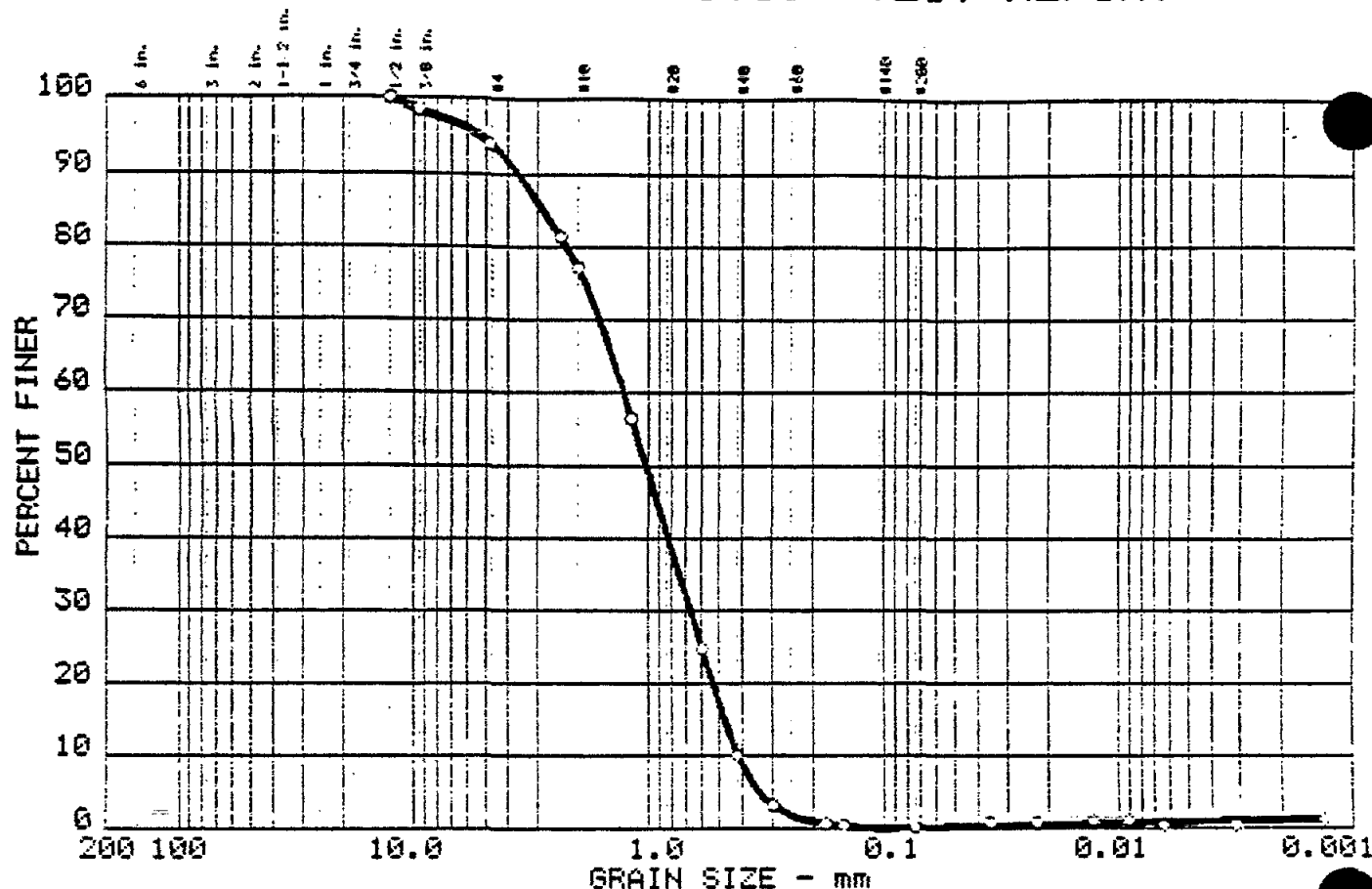
%+75_	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9	0.0	

LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
		1.12	0.83	0.74	0.602	0.4949	0.4555	0.96	1.8

MATERIAL DESCRIPTION	USCS	AASHTO
o Soil / sediment samples		

Project No.: 21-12037 Project: SAS 6026-C c Location: SAS 6026-C-003 (COBB-02) Date: 2-21-91	Remarks: USEPA Region III <div style="text-align: right;">AR300982</div> Figure No.3
GRAIN SIZE DISTRIBUTION TEST REPORT ATEC Associates, Inc.	

GRAIN SIZE DISTRIBUTION TEST REPORT



% +75	% GRAVEL	% SAND	% SILT	% CLAY
0.0	5.8	94.0	0.2	

LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
		2.79	1.29	1.03	0.656	0.4753	0.4178	0.80	3.1

MATERIAL DESCRIPTION	USCS	AASHTO
Soil / sediment samples		

Project No.: 21-12037 Project: SAS 6026-C Location: SAS 6026-C-004 (COBB-01) Date: 2-21-91	Remarks: USEPA Region III AR300983 Figure No.4
GRAIN SIZE DISTRIBUTION TEST REPORT ATEC Associates, Inc.	